QL
640
C76
UNIVERSITY MICHIGAN
DEC 1 1953
MUSEUMS LIBRARY
DIV. OF HERPETOLOGY

1953, No. 4 November 27

Copeia

ESTABLISHED IN 1913

PUBLISHED BY

THE AMERICAN SOCIETY OF

ICHTHYOLOGISTS AND HERPETOLOGISTS

Copeia *1953, No. 4* *November 27*

CONTENTS

NEW SCINCOID LIZARDS FROM THE MARSHALL ISLANDS, WITH NOTES ON THEIR DISTRIBUTION. By *Walter C. Brown and Joe T. Marshall, Jr.* 201

GROWTH, DISPERSAL AND AGE AT SEXUAL MATURITY OF THE MEXICAN TOAD (*Bufo valliceps* WIEGMANN). By *W. F. Blair* 208

VARIATION IN VENOM SAMPLES FROM COPPERHEADS (*Agkistrodon contortrix mokeson*) AND TIMBER RATTLESNAKES (*Crotalus horridus horridus*). By *Sherman A. Minton, Jr.* 212

HAWAIIAN SHALLOW-WATER FISHES OF THE FAMILY BROTULIDAE, WITH THE DESCRIPTION OF A NEW GENUS AND NOTES ON BROTULID ANATOMY. By *William A. Gosline* 215

DISTRIBUTION, MORPHOLOGY AND LIFE HISTORY OF *Lampetra aepyptera*, A BROOK LAMPREY, IN MARYLAND. By *Herbert F. Seversmith* 225

ANALYSIS OF GROWTH IN THE CENTRAL MUDMINNOW, *Umbra limi*. By *Paul S. Stokely and Clarence F. Dineen* 232

COLOR PERCEPTION IN TROUT. By *H. Wolf and J. H. Wales* 234

ICHTHYOLOGICAL NOTES

First record of the ribbonfish, *Trachipterus trachyurus*, from the mainland of North America. By *William T. Leapley* 236

Second specimen of the eel *Gorgasia punctata*, an addition to the known fish fauna of Mexico. By *Robert Rush Miller* 236

Records of the black ruffe, *Centrolophus niger*, and the mackerel scad, *Decapterus macarellus*, in the Gulf of Maine. By *Leslie W. Scattergood and Gareth C. Coffin* 237

Occurrence of the conger eel, *Conger oceanicus* (Mitchill), in the Gulf of Maine. By *C. F. Jackson* 237

Arctic or polar cod, *Boreogadus saida*, in Miramichi Bay, New Brunswick. By *R. A. McKenzie* 238

Records of uncommon fishes from Puget Sound. By *Earl T. Walker* 239

A fall record of the sand shark, *Carcharias taurus*, in North Carolina. By *William E. Fahy* 239

First record of the marine fish *Centropomus undecimalis* in South Carolina. By *G. Robert Lunz* 240

Notes on mullet (*Mugil*) swimming upside down. By *Donald P. de Sylva* 240

The orthopedic arthrometer for the precise measurement of angles in systematic ichthyology. By *Bruce W. Halstead* 241

A lighted box for tagging fishes at night. By *H. P. Mefford* 241

Constant temperature bath for experimental aquaria in linear series. By *Karl F. Lagler* 242

HERPETOLOGICAL NOTES

Longevity of snakes in captivity in the United States as of January 1, 1953. By *C. B. Perkins* 243

REVIEWS AND COMMENTS—Natural communities; by Lee R. Dice, *by C. M. Bogert:* 243.—The frog, its reproduction and development; by Roberts Rugh, *by Grace L. Orton:* 244.—Methods and principles of systematic zoology; by Ernst Mayr, E. Gorton Linsley, and Robert L. Usinger, *by Carl L. Hubbs and Robert Rush Miller:* 245.—Fresh-water invertebrates of the United States; by Robert W. Pennak, *by Robert Rush Miller:* 245.—Geographic variations of some physiological and morphological characters in certain freshwater fish; by J. S. Hart, *by Robert Rush Miller:* 246.—Between the tides; by Philip Street, *by Robert Rush Miller:* 246.

EDITORIAL NOTES AND NEWS—Summary of 1953 meeting, *by Arnold B. Grobman:* 246.—Activities of April 22: 246.—Of April 23: 248.—Of April 24: 250.—Of April 25: 252.—News notes: 253.—Gift: 254.—SWAN: 254.—Western division: 254.

Index to scientific names, 1953, Nos. 1-4: 255.

Published quarterly at Mt. Royal & Guilford Aves., Baltimore 2, Md. by the American Society of Ichthyologists and Herpetologists, The Florida State Museum, University of Florida, Gainesville, Florida. Entered as second class matter at the Post Office at Gainesville, Florida under the Act of August 24, 1912. Additional entry at the Post Office at Baltimore, Md. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized February 11, 1924.

T
fi
world,
so far
signifi
cerned
series
many
lines o
One
of mo
sexual
50 m
vent);
rows
with
occasi
a mod
50) o
neath
phalan
termin
numbe
are gr
more
The
and d
has gi
eral d
occupi
ceous,
App
of spe
line. (
samoen
be clos
more
refer t
atrocos
related
of care
ciently
ous gr
localiti
(*E. wi*

1953 No. 4 COPEIA November 27

New Scincoid Lizards from the Marshall Islands, with Notes on Their Distribution

WALTER C. BROWN AND JOE T. MARSHALL, JR.

THE members of the genus *Emoia*, confined to southeastern Asia and the Pacific world, are a comparatively uniform group in so far as characteristics of probable generic significance in the family Scincidae are concerned. However, work with the much larger series that have recently become available for many of the species suggests several divergent lines of evolution within the genus.

One such line includes members which are of moderate to large size (species not becoming sexually mature before attaining a length of 50 mm., or generally more, from snout to vent); which possess 30 to 45 (rarely more) rows of scales around the middle of the body, with the dorsal scales lacking keels except occasionally in juveniles; and which possess a moderate number (rarely below 30 or above 50) of smooth, simply rounded lamellae beneath the fourth toe, with those of the basal phalanges differentiated from those of the terminal phalanx. The latter characteristics—number of scale rows and number of lamellae—are greatly overlapped by members of other more or less distinct groups within the genus. The overdependence of Boulenger (1887) and de Rooij (1915) upon these two counts has given rise to the general confusion of several distinct species. This group of lizards occupies primarily the surface (floor), herbaceous, and low-shrub strata.

Apparently 21 published descriptions are of species that belong to this evolutionary line. (This does not include members of the *samoensis* complex which, although they may be closely related, possess more numerous and more highly modified lamellae.) Of these, 11 refer to members of the widely distributed *E. atrocostata* complex or at least to very closely related species. This complex is still in need of careful population studies based upon sufficiently large numbers of specimens from various groups of the Pacific islands and Asiatic localities. Of the remaining ten species, two (*E. whitneyi* Burt and *E. nigrita* Baird) are synonyms of *E. nigra*. The type locality of *E. nigra* is unknown, but the Marshall Islands are not included among the Pacific islands visited during the voyage of the ASTROLABE and the ZELEE whereas some of those (Samoan and Solomon Islands, for example) inhabited by the large brown to black lizard, for which this name has long been used, are included (Blainville, 1846, pp. 13–42). Furthermore, the figure of *Emoia nigra* (Hombron and Jacquinot, 1853, Atlas 2, pl. iv, fig. 2) is in agreement with examples of these populations. The frontal is shown as much longer than the fused frontoparietals; and the interparietal is fused with the latter, a condition which occasionally occurs in Solomons populations to our knowledge. Eight species—*E. boettgeri* (Sternfeld), *E. ahli* (Vogt), *E. flavigularis* Schmidt, *E. kukenthali* (Boettger), *E. nigra* (Hombron and Guichenot), *E. nigromarginata* (Roux), *E. sorex* (Boettger), *E. speiseri* (Roux)—appear to be distinct. Our conclusion in regard to *E. ahli* is based upon the literature alone and in regard to *E. speiseri* upon examination of but a single specimen. Of the remainder, three (*E. nigra*, *E. flavigularis*, and *E. boettgeri*) appear to be possibly closely related to an undescribed species, collected by the junior author and Dr. Ira La Rivers, during the summer of 1950 on Arno Atoll in the Marshall Islands. *Emoia boettgeri* is also represented by a new subspecies on the Arno Atoll.

Emoia arnoensis, sp. nov.

HOLOTYPE.—United States National Museum, No. 132131, an adult female from Chittakinmatoroen Island, Arno Atoll, Marshall Islands, collected August 15, 1950 by the junior author.

PARATYPES.—Fourteen specimens from Ijoen, Chittakinmatoroen, Eneman, East Tagelib, Pixaareji, Rakaoru Islands collected by the junior author and Dr. Ira La Rivers. Single examples are deposited in each of the following museums, except where a series is indicated:

American Museum of Natural History; Chicago Natural History Museum; Department of Biology, University of Arizona; Department of Biology, University of Nevada (series); Museum of Comparative Zoology; Stanford University Natural History Museum; and United States National Museum (series).

DEFINITION AND DIAGNOSIS.—A moderate sized, comparatively slender *Emoia* with moderately well developed limbs and relatively long toes; lamellae simply rounded, numbering 35–41 benath the fourth toe; rows of scales around the middle of the body 38–42; rows of scales along the middorsum from parietals to base of tail 69–75; interparietal moderately long; prefrontals separated; frontal very short; color glossy black (venter dark slate in a few specimens).

This species differs markedly from *E. nigra* (Bismarcks, Solomons and some groups of islands in Central Polynesia and Southern Melanesia) in its smaller size and more slender form, the relatively greater length of the supralabial beneath the orbit (subocular) in relation to its distance from the rostral, the relatively shorter frontal in relation to the length of the fused frontoparietals, the longer interparietal in relation to the parietals; from *E. flavigularis* (Solomon Islands) in the constant presence of the interparietal, the wide separation of the prefrontals, the greater number of scale rows along the middorsum from parietals to base of tail, the relatively shorter hindlimbs, the absence of the yellow color on the throat; from *E. boettgeri* in the much lower number of lamellae under the fourth toe, the somewhat larger size, the color pattern, and the relatively shorter limbs. (Table I; Fig. 1). The shorter length of the hindlimb is shown quantitatively by its ratio to the axilla-to-groin measurement which in *arnoensis* (N = 15) is 97.7 ± 1.777 and in *boettgeri orientalis* (N = 23) is 111.1 ± 1.183. In only two of fifteen specimens of *arnoensis* is the length of the hindlimb greater than the distance from axilla to groin, 110 and 111 percent, respectively; in none of the 23 specimens of the brown form measured is the length of the hindlimb less than, or even equal to, the distance from axilla to groin.

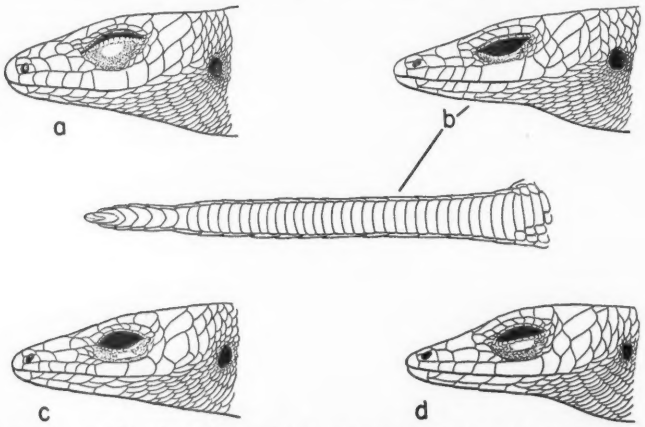


Fig. 1. Scutellation of the side of the head in four species of *Emoia* and of the under surface of the fourth toe in *E. arnoensis*. a. *E. nigra*; b. *E. arnoensis*; c. *E. flavigularis*; d. *E. boettgeri orientalis*.

There is also no evidence of a light dorsal band in the three available immatures of *arnoensis* as is generally true for juveniles of *E. nigra* and *E. flavigularis*. This condition may persist prominently in adults of *E. nigra*. It appears that *E. arnoensis* is probably more closely related to *E. flavigularis* or *E. boettgeri*.

DESCRIPTION OF HOLOTYPE—Habitus moderately slender; head narrow, its greatest breadth about equal to that of the body at the point of origin of the forelimbs; snout moderately long, its length somewhat less than half the distance from the tip of the snout to the anterior border of the ear opening, tapering and bluntly pointed; length of the anterior

loreal about three-fourths to nearly equal the length of the posterior, somewhat longer than broad, in contact with the supranasal on either side; supranasals broader anteriorly than posteriorly, separated anteriorly by a distance about equal to the greatest breadth of either supranasal; prefontals separated by a distance about equal to that separating the supranasals; frontal nearly as broad as long, shorter than the frontoparietals, broadly rounded posteriorly; interparietal about 1⅓ times as long as broad, broadly rounded posteriorly, and separating the parietals by more than half their length; a single pair of enlarged nuchals; sixth supralabial beneath the eye, its length (3 mm.), very nearly one-half its distance from the rostral (6.5 mm.); seven infralabials; postmental much longer than the mental; only the anterior pair of chin shields in contact; supraoculars four plus a small posterior one; ear opening large, its greatest diameter about twice that of the palpebral disk, without distinct lobules anteriorly; twelve rows of scales across the nape from ear opening to ear opening. Scales in 38 rows around the middle of the body; dorsals somewhat larger than the laterals, 75 rows along the middorsal line from parietals to base of tail; scales wholly smooth; 39 lamellae beneath the fourth toe on either foot, simply rounded, those of the basal phalanges

TABLE I

COMPARISON OF FOUR SPECIES OF *Emoia*

(R = range, M = mean, SE = standard error of the mean, N = number of specimens)

Characters		*nigra*	*arnoensis*	*flavigularis*	*b. boettgeri*	*b. orientalis*
Midbody scale rows	R	33–40	35–41	36–40	38–40	35–40
	M	37.13	38.80	...	39.50	38.48
	SE	0.33	0.30	...	0.43	0.27
	N	23	15	4	4	23
Lamellae on fourth toe	R	31–38	35–41	38–44	45–52	39–45
	M	34.48	38.53	...	49.00	42.65
	SE	0.35	0.46	...	0.79	0.30
	N	23	15	4	4	23
Scale rows from parietals to base of tail	R	60–66	69–74	56–62	65–69	65–77
	M	63.13	71.87	...	67.00	67.86
	SE	0.42	0.61	...	0.94	0.62
	N	23	15	4	3	22
Snout–vent length (in mm.) of mature specimens	R	75–114	60–85	55–60	59–64	55–72
	N	50	15	4	...	23
Length of interparietal/length of frontoparietal	R	16–32	33–50	(Inter-	38–47	33–50
	M	22.80	47.20	parietal,	...	39.40
	SE	1.50	1.96	absent)	...	0.87
	N	15	15	4	3	23
Length of frontal/length of frontoparietal	R	110–133	90–106	100	100–106	91–120
	M	120.30	98.90	...	...	103.10
	SE	1.96	1.04	...	...	1.47
	N	15	15	2	3	23
Length of subocular/distance from subocular to rostral	R	31–50	48–60	36–53	54–70	54–78
	M	41.10	51.80	...	...	62.30
	SE	1.56	0.90	...	...	1.32
	N	15	15	3	3	23

noticeably differentiated from those of the terminal phalanx; limbs well developed, the adpressed hindlimb reaching to the elbow.

Color in life uniformly glossy black on both dorsal and ventral surfaces. (Appears slightly lighter on the venter following preservation. Microscopic examination shows this to be due to a few scattered light flecks and the narrow lighter areas edging the scales posteriorly.)

Total length 176.5 mm. (tail regenerated); from tip of snout to vent 87; length of snout 7.5, tip of snout to ear 17.5; distance from snout to forelimb 34; distance from axilla to groin 43.5; length of forelimb 25.5; length of hindlimb 38; length of fourth toe 12.

VARIATION—Only two young adult specimens from East Tagelib Island showed any slate or bronzy color on the venter in life. Two juveniles from Eneman Island, with some light dots on the lateral surfaces and a brownish venter for one and traces of brown for the other, suggest in color pattern individuals of *E. boettgeri orientalis*.

As noted in the diagnosis of *arnoensis*, it is felt that *boettgeri*, represented by a race on this same atoll, may be a closely related species; however, the extent of morphological differences suggest, according to the senior author's experience with other species of this genus, that they have been long differentiated past the level of reproductive isolation. The distribution of the black *arnoensis* and the brown *boettgeri orientalis* is an interesting problem in itself, for they do not occur on the same islands (Fig. 2). The problem is discussed more fully at the close of the present paper.

In view of the relatively brief description of *E. boettgeri* from Ponape Island in the Carolines given by Sternfeld (1921: 406), a detailed description as well as diagnosis of the new subspecies from the Arno Atoll is given at this time.

***Emoia boettgeri orientalis*, subsp. nov.**

HOLOTYPE.—United States National Museum, No. 132132, an adult male from Ine Island, Arno Atoll, Marshall Islands, collected July 30, 1950 by the junior author.

PARATYPES.—Twenty-two specimens from Ine, Dodo and Autore Islands collected by the junior author and Dr. Ira La Rivers. Single examples are deposited in each of the following museums except where a series is indicated; American Museum of Natural History; Chicago Natural History Museum; Department of Biology, University of Arizona; Department of Biology, University of Nevada (series); Museum of Comparative Zoology; Stanford University Natural History Museum; Museum of Vertebrate Zoology; British Museum (Natural History); Museum National d'Histoire Naturelle, Paris; Rijksmuseum van Naturlijke Historie, Leiden; United States National Museum (series).

DIAGNOSIS.—A moderate sized, brown *Emoia* most closely related to *E. boettgeri* from which it differs primarily in the lower number of lamellae beneath the toes.

DESCRIPTION OF HOLOTYPE.—A moderate sized *Emoia* of slender habitus; snout rather long, pointed, moderately depressed; anterior loreal about equal in length to the posterior, somewhat broader (higher), in contact with the supranasal on either side; supranasals moderately narrow, elongate; prefrontals large, moderately separated; frontal longer than broad, its length about equal to that of frontoparietal; interparietal moderate, elongate; supraoculars four plus a small one posteriorly; fifth supralabial (subocular) largest, its length more than half (65 percent) its distance from the rostral; ear opening rather large, its diameter greater than that of the palpebral disk, with one or two small lobules anteriorly; ten rows of scales across the nape from ear opening to ear opening. Scales in 39 rows around the middle of the body; dorsals somewhat larger than the laterals; 69 rows along the middorsal line from the parietals to the base of the tail; scales smooth; 43 lamellae beneath the fourth toe on either foot.

Color in life dark, iridescent, olive brown above with some scattered darker blotches; a few light spots corresponding in size to a single scale on the upper lateral surfaces; limbs similarly marked. The venter is yellow except for the throat and tail which are bluish white and greenish white respectively.

Total length 158 mm.; length from tip of snout to vent 66; length of snout 6.5; distance from snout to forelimb 27; distance from axilla to groin 30; length of hind limb 34.5; length of fourth toe 10.5.

VARIATION.—The yellow color is lost in preservative, becoming generally whitish. Specimens preserved in formalin are darker in

general. The color pattern of juveniles is essentially identical with that of adults.

Discussion

The occurrence of two very similar, but strictly allopatric populations of *Emoia* on the Arno Atoll suggests three possible interpretations: (1) a polymorphic species; (2) isolated subspecies; (3) sibling species—allopatric due to competition. Acceptance of the third interpretation is manifest by our nomenclature.

Were the variation due to polymorphism within a single species, one would expect to find at least a few individuals of "opposite" coloration in some of the populations. However, of a total of 229 individuals seen (including 133 seen on five islets containing the brown *boettgeri orientalis*, one of them on the neighboring atoll of Majuro, and 96 on seven islets containing populations of black *arnoensis*), not a single individual was of color unlike that of the prevailing population. The two juveniles of *arnoensis* from Eneman Island, whose color pattern suggests that of the brown form, may seem to be exceptions and by themselves might suggest intergradation. However, it should be noted that, of 23 adults observed on that island, all were glossy black. Such juvenile dimorphism has its general parallel, as previously noted, in the light dorsal band of juveniles of *E. nigra* and *E. flavigularis*.

It might be argued that random fixation of genotypes among the small populations of islets would result in the kind of divergence shown, assuming the atoll was originally tenanted by a single variable species, but there is no evidence for this. Based upon a count of four individuals in a study plot of 2322 square yards across a narrow portion of Ine Island, one can estimate total populations of *E. boettgeri orientalis* ranging from 53 to 7600, and of *E. arnoensis* from 69 to 3500 for the various islands. For the smallest islets these figures are from 2.5 to 5 times in excess of individuals actually observed. No islet less than .01 square mile is inhabited by either species, and several islets larger than this are uninhabited (Fig. 2). Granting the small population sizes involved, there is nothing "random" in the fixation of only one or the other of the two alternate genotypes in 12 populations considered here, unless one regards all the characters (size, color, scutellation and proportions) as determined by a single pair of alleles.

Accidents of colonization may possibly account for the strange distribution of these two populations, whether regarded as races or full species. In considering this problem, it must be mentioned that severe typhoons strike the atoll four or five times a century, washing away land and vegetation, thus producing a chain of disconnected islets separated

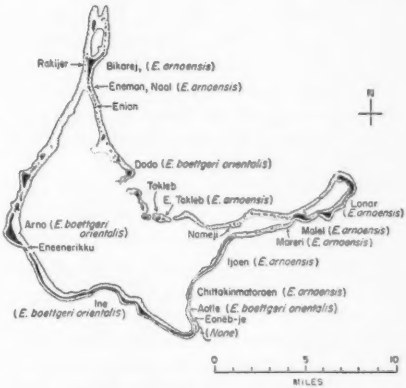


Fig. 2. Distribution of *Emoia arnoensis* and *E. boettgeri orientalis* on Arno Atoll.

The map is adapted from that of John H. W. Wells in Atoll Research Bull., 1951, No. 9, Pacific Sci. Board, Washington, D. C. Since names of the islets in the atoll have not been standardized, spellings used in the text do not always agree with those used on the map. Equivalents are as follows: Aotle = Autore; Bikarej = Pikaareji; Lonar = Rakaaru; Takleb = Tagelib.

by barren reef. The connections tend to be rebuilt and revegetated in the intervening years except across the deep passes on the north-central section (Fig. 2). Prior to the typhoon of 1905, there was only one canoe passage (and probably also only the same break in the vegetation) between Rakaaru (extreme north-east tip of the atoll) and the west end of Ine Island (Agassiz, A., 1903: 228). This passage was near Autore Islet; it could have been on its north border, and may have separated a continuous population of *E. arnoensis* to the north from a similarly continuous population of *E. boettgeri orientalis* to the west. Allowing for such former connections in land areas, we have among the 12 existing known populations at least three separate colonizations for each form, involving much the greater portion of the atoll. It seems a coincidence

that of six invasions, no two arrived at the same area.

The habits of these lizards further militate against the idea of chance invasion. They are ground dwellers, active among rocks, at the edge of the vegetation, around the bases of breadfruit trees in clear parts of the forest, in houses, piles of coconuts and thatch. They could easily get into canoes drawn up at the edge of the vegetation (as other skinks and gekkos have been observed to do at Arno) and be carried from one part of the atoll to another, or be carried in loads of coconuts or thatch. For the present, therefore, it seems best to regard the present distribution pattern of these two species of *Emoia* as persisting in spite of repeated introductions of both forms, all over Arno Atoll.

What then permits only one or the other species to persist upon a given islet? Their food habits appear to be identical; they eat earthworms, ants, maggots, other insects, and occasionally rotten breadfruit. They do not form the principal food of any predator, and are only very rarely eaten by chickens, New Zealand cuckoos (*Eudynamis taitensis*) and reef herons. It is likely that the two forms compete with each other for food, habitations and forage areas to the extent that one drives out the other. It may be noted that each foraging area, such as the base of a large breadfruit tree, thatched house, pile of coconut husks, etc., is almost invariably occupied by only two individuals (possibly the members of a pair). Thus one might assume the existence of intolerance toward other individuals of the same species, which might operate for individuals of the sibling species, should they come together. According to Gause (1934), working with cultures of protozoans and of yeasts competing for the same food, no two species of similar ecologic requirements can exist together for long. If this rule holds for vertebrates, it can be assumed that these two Arnoese skinks are so similar in their requirements that they compete with each other and cannot, therefore, coexist. (A third species, *Emoia cyanura*, is abundant on all of the islands occupied by either *E. arnoensis* or *E. boettgeri orientalis* but the coaction is apparently not disharmonious.) It must be emphasized that this type of reasoning does not constitute substantiation of Gause's rule for vertebrates. In the same way that Lack (1947) concludes from the rule that *since* three sibling species of *Geospiza* are sympatric on certain islands of the Galapagos, *therefore*, they must avoid competition by having different requirements; so we state somewhat tentatively that since two sibling species of *Emoia* do not occur sympatrically (in spite of apparent opportunities to do so) on Arno, therefore they have similar requirements and compete with each other. Although Lack would have us believe (*op. cit.*) that in birds sibling species in general avoid competition, it should be noted that at least in sympatric species of the bird genera *Sturnella*, *Tyrannus* and *Myiarchus* as seen in Arizona or Sonora, Gause's rule is not as easily applied.

In what seems to be such a uniform and monotonous environment as such an atoll, it is not obvious why one form of *Emoia* should establish itself on some islets, and the other form on other islets. There actually are some discernible differences in habitat occurrence of the two species at Arno Atoll. *E. arnoensis* is found on the wildest portions of the atoll, where there are remnants of the original native forest with a dense understory vegetation. Here, in order to find the amount of openness the lizards desire, they are forced out to the edge of the forest, around houses and among rocks at the edges of the islets, under scattered bushes (*Scaevola*). The three main populations of *E. boettgeri orientalis*, on the other hand, occur on the islands containing the greatest centers of the human population (Arno, Dodo, Ine), where the coconuts are most intensively tended and harvested, and the undergrowth burned. The brown species penetrates the interior of these islands, whenever the undergrowth is kept down. Although these differences are not absolute, for upon any one island the entire gamut of foraging places can be found and are occupied by whichever species is there, yet on the average, *E. boettgeri orientalis* is more apt to be found in the open interior, *E. arnoensis* among rocks at the edge of the vegetation. Both, of course, are found in houses and in piles of coconut husks. *E. arnoensis* is on the average more exposed to direct sunlight than is the brown species. The latter is sensitive to sunlight. It leaves its roost (4–6 feet above ground, in leaves) to forage in the morning only after the

sun strikes it. A strong substantiation of the hypothesis that selective forces might operate differentially upon the two species, thus determining which will "win out" in a given islet environment, is further suggested by the relative frequency of different color phases in the polymorphic tree-dwelling skink, *Dasia smaragdina* of Arno. Individuals of the species collected or seen in the field are classified into five color phases tabulated here by occurrence on islets with *Emoia arnoensis* or *Emoia boettgeri orientalis:*

	Yellow-green	Green	Olive	Olive-brown	Black
Ine, Arno, Dodo, with *E. b. orientalis* (71).....	9	24	22	14	2
Other islands, with *E. arnoensis* (48)	4	13	2	20	9

The above observations suggest that the proportion of light-colored (yellow-green, green and olive) individuals on those islets occupied by the brown *E. boettgeri orientalis* is higher than should be expected and that the dark (olive-brown and black) phases predominate on those islets occupied by the black *E. arnoensis*. Calculation of the expected frequencies of the light and dark phases, respectively, reveals the following:

	Yellow green, green and olive		Olive-brown and black	
	Observed	Expected	Observed	Expected
Ine, Arno, Dodo with *E. boettgeri orientalis* (71)..	55	37.8	16	23.0
Other islands with *E. arnoensis* (48)....	19	24.9	29	15.5

The probability (based upon a Chi-square test) that these two samples are from a homogeneous population with respect to the distribution of light and dark color phases is less than 0.001, whether the calculation of the Chi-square value is made on the basis of five color phases as distinct categories, or on the basis of two classes, light and dark.

Conclusions

The morphological evidence, discussed earlier in the present paper, indicates that the two populations are sibling species. Available evidence as to their habits strongly suggests that they are allopatric as a result of competition in ways as yet not fully understood.

Acknowledgements

The field work was done by the junior author and Dr. Ira La Rivers, under the auspices of the Pacific Science Board of the National Research Council, supported by funds granted by the Office of Naval Research. Illustrations, prepared by Miss Margaret Bradbury of the Chicago Natural History Museum, were made possible by a grant from the Graduate School of Northwestern University. We wish to thank Messrs. Clifford H. Pope of the Chicago Natural History Museum and Arthur Loveridge of the Museum of Comparative Zoology, Harvard University, for their kindness in permitting us to use comparative material. We also owe thanks to Drs. Ernst Mayr, Robert L. Usinger, Mason E. Wescott, Karl P. Schmidt and Orlando Park for helpful suggestions while this paper was in preparation.

Literature Cited

Agassiz, A. 1903. Reports of the scientific results of the expedition to the tropical Pacific, ... IV, The coral reefs of the tropical Pacific. *Mem. Mus. Comp. Zool., 28: xxxiii + 410 pp., 236 pls.*

Blainville, H. M. D. de. 1846. Rapports faits a l'Academie Royale des Sciences de l'Institut de France .... in Hombron and Guichenot, voyage au pole sud et dans l'oceanie sur les corvettes l'Astrolabe et la Zelee. *Zoologie, 1: 1–404.*

Boulenger, G. A. 1887. Catalogue of the lizards in the British Museum. 2nd ed. *London: 16 + 503 pp., text figs., 30 pls.*

de Rooij, Nelly. 1915. The reptiles of the Indo-Australian archipelago. I. Lacertilia, Chelonia, Emydosauria. *Leiden: xv + 384 pp., text figs.*

Gause, G. F 1934. The struggle for existence. *Williams and Wilkins, Baltimore: ix + 163 pp.*

Jacquinot, H., and Guichenot, A. 1853. Reptiles et Poissons in Hombron and Guichenot, voyage au pole sud et dans l'oceanie sur les corvettes l'Astrolabe et la Zelee. *Zoologie, 3: 1–56.*

Lack, David. 1947. Darwin's finches. *Cambridge University Press, London: x + 208 pp., pls. 1–8.*

Maerz, A., and M. Rea Paul. 1930. A dictionary of color. *McGraw-Hill Book Company, New York: vii + 207 pp., 56 pls.*

Schmidt, Karl P. 1932. Reptiles and amphibian from the Solomon Islands. *Field Mus. Nat. Hist., Zool. Ser., 18: 175–90.*

Sternfeld, Richard. 1921. Zur Tiergeographie Papuasiens und der Pazifischen Inselwelt. *Abh. Senckenbergischen Naturf. Ges., 36: 375–436, pl. 31.*

Department of Biology, Northwestern University, Evanston, Illinois, and Department of Zoology, University of Arizona, Tucson, Arizona.

Growth, Dispersal and Age at Sexual Maturity of the Mexican Toad (*Bufo valliceps* Wiegmann)

W. F. Blair

THE dynamics of natural populations are extremely important to the survival of species and to their differentiation in time and space. Hereditary changes may provide the basis for adaptation, survival and differentiation, but these changes are evolutionarily significant only in a population that is meeting the problems of existence in its natural environment. Remarkably little is known, however, about the behavior in natural populations of most kinds of vertebrates. The present report deals principally with two phases of population dynamics (age of reaching sexual maturity and survival to sexual maturity) in a population of the Mexican toad (*Bufo valliceps* Wiegmann).

The study was begun on July 21, 1951, when it was discovered that many young toads hatched in June and July had failed to disperse from the dirt "tank" from which they had metamorphosed or had moved to regularly watered areas some 100 to 235 feet distant from the tank. In the period of July 21 to October 22, 1951, a group of 357 young toads in the size range of 10 to 55 millimeters was marked by toe clipping. Observations on this population have been continued to October, 1952.

The Environment

The work was done about 5 miles east of Austin, Texas, in an area where mesquite (*Prosopis juliflora*) brush predominates on the uplands and cedar elm (*Ulmus alata*) is the dominant plant in ravines. The dirt tank is stocked with largemouth bass (*Micropterus salmoides*) and bluegills (*Lepomis macrochirus*) and has small populations of red-eared turtles (*Pseudemys scripta*), yellow mudturtles (*Kinosternon flavescens*) and common snapping turtles (*Chelydra serpentina*). The margin of the tank has a comparatively large population of bullfrogs (*Rana catesbeiana*), a large population of cricketfrogs (*Acris crepitans*) and a few leopardfrogs (*Rana pipiens*). Snakes are scarce around the margin of the tank. One red-bellied watersnake (*Natrix erythrogaster*) was found dead there in July, 1952. Ribbonsnakes (*Thamnophis sauritus*) and gartersnakes (*Thamnophis marcianus*) are scarce. On 10 acres surrounding the tank, 7 blueracers (*Coluber constrictor*), 10 coachwhips (*Coluber flagellum*), 6 ratsnakes (*Elaphe obsoleta*), 8 patch-nosed snakes (*Salvadora lineata*) and 16 rough greensnakes (*Opheodrys aestivus*) were marked during the summer and fall of 1952.

The soil exposed by shrinkage of the tank in summer is a black silt that cracks deeply as it dries. The soil on the uplands is a gravelly clay that bakes to very hard consistency during summer droughts.

Dispersal

The concentration of baby toads in August, 1951, was apparently unusual for the species in this region. No such aggregation was observed in the summer of 1950. In 1952, no baby toads were found around the margin of the pond during careful and frequent observation in July and August. A few recently metamorphosed toads were found there in September and early October of 1952, but there was no concentration, and following a rain in the first week of September more were found away from the tank than were seen at the margin. The failure of many of the young toads to disperse from the pond margin in 1951 and the concentration of dispersed individuals around regularly watered areas presumably resulted from the drought that prevailed in the area. No soaking rain fall in the vicinity between June 12 and August 19, 1951, although 0.17 inches fell on July 14. On August 19, 1.95 inches fell in the area and 0.12 inches came the next day. During these two days, the populations of baby toads virtually disappeared from the tank margin and from the watered areas, and subsequent observations in the summer and fall revealed only a few individuals at any of these locations. Eight of the toads that had been marked at the tank were recorded from the watered areas in the period between August 19 and October 6, 1951, but none of the toads that had been marked away from the tank was recovered back at the tank during this period.

The only movement of a young toad from a watered area back to the tank occurred during the dry period, when a toad marked 235 feet away on July 21 was retaken at the tank margin on August 6. This animal had a snout-vent length of 36 mm. on the latter date. There seems no question but that dispersal of the toads from the tank and from the secondary concentrations had been inhibited by the dry weather and that the rains stimulated mass dispersal of the concentrated populations.

The young toads marked around the edge of the tank averaged much smaller than those that had dispersed to secondary concentrations in the watered areas (Table I). The discrepancy in size is even greater than is indicated by comparison of the marked toads, for no toads were marked that had a snout-vent length of less than 10 mm. because of the difficulty of clipping their toes. No toads of less than this length were found away from the tank, but considerable numbers of them were present at the tank margin. The generally smaller size of the tank-margin toads might have been due simply to the fact that these were mostly from a later hatch than those living around the watered areas, or it might have indicated that the parched soil of the surrounding terrain was a greater deterrent to dispersal of the smaller individuals. That the latter explanation holds in part is supported by the fact that even the smallest of the toads dispersed during the rainy period of August 19 to 20. It is also supported by the fact that the larger young toads were able and willing to move across dry soil in moving from one to another of three watered areas. During the rainless period of August 7 to 18, seven young toads, having a range in snout-vent length from 24 to 31 mm., made a total of 13 moves of 55 to 100 feet between watered areas and, as already noted, one toad moved 235 feet back to the tank. The population at the tank probably included toads of varying ages, with younger individuals predominating because of difficulty of dispersal over dry soil. Such concentrations as this and the secondary concentrations in watered areas are obviously disadvantageous to survival of the population because of the vulnerability of such aggregations to predation.

TABLE I

SIZE OF UNDISPERSED YOUNG TOADS (*Bufo valliceps*) AND OF TOADS THAT HAD DISPERSED TO NEARBY WATERED AREAS. SUMMER AND FALL, 1951, ABOUT 5 MILES EAST OF AUSTIN, TEXAS

Location	Period	Number marked	Size range, snout-vent, in mm.	Mean snout-vent length, in mm.	Percentage less than 20 mm. in snout-vent
Tank (undispersed)	Aug. 6-17	255	10–38	18.26	71.37
Watered areas	Aug. 6-17	78	17–43	27.31	1.28
Watered areas	July 21-Aug. 4	13	23–37	28.23	0.00
Watered areas	Aug. 18-Oct. 22	11	15–52	34.54	9.09

SURVIVAL TO SEXUAL MATURITY

Twenty-five of the 357 toads marked as juveniles in the summer and fall of 1951 were recovered in the summer of 1952, when they gave evidence of being sexually mature. Twenty of the toads recovered in 1952 were males, and only five were females. This is not taken to indicate a differential survival rate in the sexes, but probably results from the greater difficulty in recovering females. Because it was not possible to determine the sex of the juvenile toads, an assumption is necessary if we are to estimate the percentage survival to sexual maturity. It seems fairly safe to assume that the sex ratio was essentially even in the juvenile population. If this is so, then approximately 178 juvenile males were marked in 1951. The recovery of 20 of these in 1952 would indicate that at least 11.2 percent of the males survived to sexual maturity. I suspect that the females would have shown a similar percentage of survival if they had been as easily recovered as the males.

One immediately apparent problem in evaluating the estimate of survival is whether or not dispersal may have taken some individuals out of the area under study. Sixteen of the males were recovered in breeding congresses in the same tank from which they presumably metamorphosed. One other was recovered in a breeding chorus in a temporary pool about 500 feet from the tank. Only two males were recovered outside of breeding aggregations. One was taken in July and one in August, and both were about 200 feet from the

tank. Only one of the toads, a male, was recovered away from where it was breeding or would be expected to breed in the tank or in the nearby temporary pool. This individual was retaken by W. A. Thornton in a dirt tank about one-half mile away, where it was in a breeding chorus in May. The five females were recovered outside of breeding choruses and all within 250 feet of the tank over a period from June to September. It is impossible to be sure that some of the toads did not disperse beyond the area covered by the field work that was done. It is consequently doubtful that all surviving males were recovered and almost certain that all females were not retaken. The number of unrecovered males was probably small, however, as extensive checking of breeding choruses in the general area by myself and other workers revealed only the one male that had moved away from the site of its origin.

Age and Size at Sexual Maturity

Eleven of the males that were marked as juveniles in 1951 were recovered as members of a breeding chorus in the period of April 16 to 20, 1952. This was the first breeding aggregation in the tank in the spring of 1952. At this time the eleven males were approximately 10 months of age. All of these animals were calling, showed secondary sex characters, and showed the clasp reflex when tested. In snout–vent length, these animals ranged in size from 61 to 78 mm. (Table II). No females were recovered until June, 1952, and these were not in breeding aggregations. This is not taken to indicate that the females mature any more slowly than the males but that the females were less easily recovered. The two females taken in June had snout–vent lengths of, respectively, 93 and 95 mm., at which time they were larger than some females that have been observed in amplexus. One of the five females (No. 600) was much smaller than the others (Table II), and this may not have been the animal marked 600 in 1951. As the number 600 involves the cutting of only two toes, accidental loss of toes might account for the recording of this toad as a marked one.

The measurements of any one individual are too few to permit construction of an adequate growth curve, but there is some indication of the rate of growth at different ages (Table II). Growth is very rapid in the first summer, slows greatly the following winter, accelerates somewhat the following spring and slows again as the animal approaches mature size in the following summer. Male 554 grew 39 mm. in length between August 17 and October 30, 1951, and averaged 0.53 mm. of elongation per day. It grew only 12 mm. between October 30, 1951, and April 18, 1952, at an average rate of only 0.07 mm. per day. Female 321 grew 30 mm. in length between August 8 and September 8, 1951, at a mean rate of 0.57 mm. per day, but this animal grew only 40 mm. between September 30, 1951, and June 23, 1952, at an average rate of only 0.15 mm. per day. The growth rate in the spring varied between the few individuals for which records are available, but it was generally more rapid than the winter growth rate. Male 285 grew 7 mm. between April 16 and May 9, 1952, at an average rate of 0.31 mm. per day. Male 310

Table II

Snout–Vent Length Measurements in Millimeters of Toads that Were Recovered as Sexually Mature Adults After Being Marked as Juveniles

Toad number	1951			1952					
	Aug.	Sept.	Oct.	Apr.	May	June	July	Aug.	Sept.
Males									
245	34	..	..	73	..	..	...	83	...
256	29	..	..	68	..	..	...	..	...
285	19	..	..	66	73	..	...	..	...
286	20	..	..	..	72	..	...	..	...
305	24	..	..	78	..	..	...	..	...
309	31	..	..	70	..	..	...	..	...
310	21	..	..	..	77	..	86	88	...
400	15	..	..	..	64	..	...	..	...
404	21	..	..	63	..	..	...	..	...
413	17	..	..	61	..	..	...	..	...
500	12	..	..	..	..	..	75	..	...
508	15	..	..	..	77	..	81	79	...
554	16	..	55	67	..	..	...	..	...
558	19	..	..	..	..	..	...	75	...
564	21	..	..	..	..	..	78	79	...
568	19	..	..	..	..	..	71	75	...
593	..	44	..	77	..	..	...	..	...
601	..	68	..	73	..	..	...	..	...
603	..	..	52	75	..	..	...	..	...
Females									
449	29	..	..	..	..	95	102	..	104
552	15	..	..	..	..	..	...	..	86
587	25	..	..	..	..	..	97	..	...
600	38	..	..	..	..	..	...	..	70
321	23	53	..	..	..	93	...	..	..

grew 9 mm. between May 31 and July 19 at an average rate of 0.16 mm. per day, but this animal grew only 2 mm. between July 19 and August 25 at a rate of only 0.05 mm. per day. Male 508 grew 3 mm. between May 31 and July 19 at an average rate of 0.08 mm. per day. The measurement of this individual on August 13 (Table II) was 2 mm. less than that made on July 19, which is undoubtedly due to an error in measurement. Female 449 gained 7 mm. between June 23 and July 21 at an average rate of 0.25 mm. per day, but this animal grew only 2 mm. between July 21 and September 23 at an average rate of only 0.03 mm. per day. If the growth records are averaged by seasons a crude estimate of the growth rate at the different times is obtained. For the first summer after hatching the average daily rate of elongation is 0.55 mm.; for the following winter it is 0.11 mm.; for the following spring it is 0.20 mm.; and for the following summer it is 0.04 mm.

Discussion

Almost nothing is known about growth rates or length of time to sexual maturity in the genus *Bufo*. Most of the few estimates available are almost worthless because they come from attempts to resolve size classes in preserved material into yearly age classes. In forms such as the toads, in which there may be a long breeding season and in which growth rate may be strongly influenced by environmental factors, such an approach leads to results that are highly suspect. For example, Stebbins (1951) quoted three workers who respectively believed that in *B. cognatus* adult size may be reached in two years by some individuals but not by others for 3 or 4 years, or at least 5 years are required for full growth, or at least 4 and possibly 5 years are required. Wright (1932) recognized eight presumed annual classes in preserved *B. terrestris* but pointed out the difficulty of making growth estimates without records of marked specimens.

Only one previous report of the size and age at sexual maturity in toads from marked individuals is known to me. A. P. Blair (1941), working with laboratory populations, reported the size and age of eight hybrid males at time of sexual maturity. These animals included three hybrid combinations of *B. woodhousei*, *B. fowleri*, and *B. americanus*. Age at sexual maturity was given as 8.5 to 18 months, and size at sexual maturity was 43.2 to 58.0 mm. The males in my natural population of *B. valliceps* matured at an earlier age than the average in A. P. Blair's laboratory hybrids, and they were considerably larger than the laboratory hybrids. The differences may be due in part to the fact that a "pure" population was studied in the one case, while hybrid combinations of three different species were studied in the other. The differences may also be due in part to the fact that one was a natural and the other a laboratory population. If we consider that, as my own experience would tend to indicate, laboratory raised anurans tend to grow and mature more slowly than those in their natural environment, then A. P. Blair was working with species in which individuals probably breed in the first season following the one in which they were produced. At the least, A. P. Blair's results suggest that the comparatively rapid growth and maturation, as found in *B. valliceps*, may be typical of other species as well. Studies of other species, particularly of those living in colder climates, where temperatures average lower and growing seasons are shorter, are needed to indicate the variations in growth rate in toads.

The rapid growth and early sexual maturation of *B. valliceps* is not unexpected when we consider the indicated survival of only about 11 percent of the young animals to the succeeding breeding season. Delay of sexual maturity until the second, third or even fifth year, as has been suggested for some species, would hardly seem to permit replacement of losses from the population if the rate of attrition is high. One comparison is of interest. In the deermouse (*Peromyscus maniculatus*) Howard (1949) found that less than one-fifth of the young born survived to sexual maturity, which was usually reached within 4½ to 9 weeks after birth. The fraction of the population surviving to sexual maturity is even lower in the toads if my estimate of approximately 11 percent is valid. One surviving female toad, of course, is potentially capable of producing far more offspring than one surviving female mouse. On the other hand, the mortality is evidently very high in the early stages of ontogeny of the toad. In this respect it is signifi-

cant that all of the young toads marked in 1951 and probably all of the metamorphosed toads in the area represented but a fraction of the potential production of a single female.

Summary

An exceptional concentration of baby Mexican toads (*Bufo valliceps*) in the summer of 1951 permitted the marking of 357 individuals in the size range of 10 to 55 mm. snout–vent length. The aggregations of baby toads at the pond of origin and in nearby watered areas apparently resulted from inability or reluctance of the smaller toads to disperse during drought conditions. The concentrations were broken up by mass dispersal during two rainy days on August 19 and 20.

Twenty marked male and five female toads were recovered in the spring and summer of 1952. It is estimated that about 11 percent of the marked males survived to sexual maturity, and it is doubtful that the survival rate for the females differed from that for the males. Sexual maturity was reached in the breeding season of the year following the one in which the toads were hatched. Eleven of the recovered males were taken as participants in the first breeding aggregation of the 1952 season. At that time they were about 10 months of age and ranged in size from 61 to 78 mm. in snout–vent length. Our limited information about growth rates indicates rapid growth in the summer of hatching, slow growth the following winter, some acceleration the following spring, then a slowing as the animal approaches mature size the following summer.

Literature Cited

Blair, Albert P. 1941. Variation, isolation mechanisms and hybridization in certain toads. *Genetics, 26: 398–417.*

Howard, Walter E. 1949. Dispersal, amount of inbreeding, and longevity in a local population of prairie deermice on the George Reserve, southern Michigan. *Contrib. Lab. Vert. Biol. Univ. Michigan, 43: 1–50.*

Stebbins, Robert C. 1951. Amphibians of western North America. *Univ. California Press, Berkeley: ix + 539 pp.*

Wright, Albert Hazen. 1932. Life-histories of the frogs of Okefinokee Swamp, Georgia. *Macmillan, New York: xv + 497 pp.*

Department of Zoology, University of Texas, Austin 12, Texas.

Variation in Venom Samples from Copperheads (*Agkistrodon contortrix mokeson*) and Timber Rattlesnakes (*Crotalus horridus horridus*)

Sherman A. Minton, Jr.

The hazard in any given case of snake-bite depends largely upon the number of lethal doses of venom or fraction thereof that the snake injects into the tissues of the bitten individual. This in turn depends, in very great degree, upon the toxicity of the venom and the amount injected; although other factors such as the depth and location of the bite may be important. Variation in quantity and toxicity of venom in individual reptiles is, therefore, worthy of investigation; for it is to be anticipated that a glandular secretion such as snake venom should show considerable variation among individuals of the same species as well as in the same individual under different conditions of health and disease. For most snakes, information of this nature is very scanty. Such is the case with two of the best known snakes of the eastern United States, the timber rattlesnake, *Crotalus horridus horridus* Linné, and the copperhead, *Agkistrodon contortrix mokeson* Daudin. Githens (1935) gave maximum and minimum venom yields obtained from a number of North American pit vipers and called attention to a marked variation in the toxicity of venom samples obtained from the timber rattlesnake, *Crotalus horridus* subsp. Githens and George (1930) stated that the venom of timber rattlesnakes from the western part of the range is much more toxic than that of snakes from New York and Pennsylvania. This paper presents some of the variation encountered in

venom samples from seven timber rattlesnakes and eight copperheads.

With the exception of a single copperhead from southeastern Kentucky, all the snakes were collected in the hill counties of southern Indiana, the majority of them in the Brown County State Park. The snakes had been in captivity 6 days to 3 months at the time of venom extraction. Several of them had fed at irregular intervals. Although some were rather thin, all were in good physical condition except one copperhead. Several of the female snakes were gravid. There were no very large snakes in the series; sizes ranged from moderately large adults to subadults. A 10½-inch copperhead was captured during the study, but a satisfactory venom sample could not be obtained.

All of the venom samples were obtained during a period of one month; and nearly all on one day. Each snake was milked once. With the reptile grasped behind the head, the fangs were hooked over the edge of a conical bottomed centrifuge tube and pressure exerted over the venom glands. The liquid venom was removed from the tube and measured by aspirating it into a tuberculin syringe fitted with a 22-gauge needle. The venom sample was then expelled into a clean watch glass and evaporated to dryness by placing the watch glass in a petri dish containing "Drierite" (anhydrous calcium sulfate). The dry venom was carefully flaked off the glass with a small spatula, weighed, and placed in a dry 2-milliliter vial. The vials were stored in a small desiccator in the refrigerator until used. In most samples, the venom was dried within an hour after collection. When this was not possible, the sample was stored at −40°C. in a low temperature cabinet.

All venom samples were tested for toxicity within two months after they were collected. Toxicity was determined by intraperitoneal injection of white mice. Animals were weighed individually, and the mice used for each venom sample did not vary more than 1½ grams from the median weight which was 20 grams in most of the determinations. The venom was prepared for injection by dissolving it in distilled water to a concentration of 1 milligram per milliliter. Groups of four mice received doses of 0.05, 0.10, 0.15, and 0.20 milligram, respectively. If animals were alive in the 0.15-milligram group 24 hours after injection, an additional group of mice was injected with 0.25 milligram of venom; if death had occurred in the 0.05-milligram group, additional mice were injected with a dose of 0.01 milligram. All deaths occurring within a 72-hour period following injection were ascribed to the effects of the venom. The 50 percent Lethal Dose (or LD 50), i.e., that dose theoretically expected to kill half of the animals receiving it, was calculated by the method of Reed and Muench (1938). This dose was then expressed in terms of milligrams per kilo of experimental animal. The number of mouse LD 50's in the sample was calculated on the basis of an animal weighing 20 grams (Table I).

Three rattlesnakes and three copperheads were killed 24 hours after milking. At death only a tiny amount of venom, less than 0.05 milliliter, could be expressed, indicating that the venom yields which were obtained represented virtually the entire contents of the snakes' glands. As anticipated, the larger venom yields came from the larger snakes. The largest rattlesnake venom sample (0.71 ml. with a weight of 249 mg.) came from a 48-inch female that had refused food throughout captivity. In contrast, a 47-inch male rattlesnake that had fed during a comparable period of captivity produced 0.60 milliliter of venom with a weight of 194 milligrams. The two largest rattlesnakes gave comparatively low yields; however one of these snakes had been recently captured and had expended a large part of its venom in the resultant struggle, and part of the other snake's venom was lost during extraction. The largest copperhead venom yield (0.29 ml. with a weight of 98 mg.) came from the largest snake, a 41-inch male. It is probably not maximum for a snake of this size, since I once obtained 142 milligrams of venom from a 45-inch copperhead. The proportionally highest copperhead yield came from a 24-inch female that gave a volume of 0.22 milliliter with a weight of 72 milligrams. The yield of venom in milligrams per inch of snake, while probably not a very meaningful relationship, indicates that timber rattlesnakes produced proportionally more venom than copperheads. The mean value for the rattlesnakes was 3.39 milligrams per inch; for the copperheads it was 1.87 milligrams per inch.

The amount of solid material in the samples was fairly constant. The mean value for the timber rattlesnakes was 320 milligrams of

dry venom per milliliter of liquid material; for the copperheads, 348 milligrams per milliliter. The copperhead samples, therefore, contained slightly more solids per unit volume.

Individual variations in toxicity were greater than anticipated. The strongest rattlesnake venom sample was more than twice as toxic as any other sample examined and five times as toxic as the weakest sample. Its toxicity had random. The most toxic and least toxic rattlesnake samples came from snakes captured the same day in the same locality. Both were adult females and were gravid. As far as could be ascertained, neither fed in captivity. There was no noticeable difference in their health and state of nutrition. The most potent copperhead sample came from a gravid female that had refused food during six weeks of captivity. The

TABLE I

YIELDS AND TOXICITY OF VENOM FROM SEVEN RATTLESNAKES AND EIGHT COPPERHEADS

Species and locality	Length (inches) and sex	Venom volume (ml.)	Venom weight (mg.)	Mg. venom per inch snake	Mg. dry venom per ml.	LD 50 in mg. per kilo	Number mouse LD 50 in sample	Remarks
Timber rattlesnake								
Orange Co., Ind.	50 ♂	0.34	116	....	341	5.80	991	Much venom lost during milking
Morgan Co., Ind.	47 ♂	0.60	194	4.12	323	6.90	1405	....
Morgan Co., Ind.	51 ♀	0.40	127	2.44	317	4.15	1530	....
Brown Co., Ind.	42 ♀	0.55	173	4.10	314	1.48	5766	Gravid
Brown Co., Ind.	40 ♀	0.35	104	2.59	296	3.52	1485	....
Brown Co., Ind.	37 ♂	0.23	69	1.86	300	6.10	565	....
Brown Co., Ind.	48 ♀	0.71	249	5.28	351	7.80	1596	Gravid
Copperhead								
Morgan Co., Ind.	24½ ♂	....	30	1.23	....	3.80	396	....
Jackson Co., Ind.	24 ♀	0.22	72	3.00	328	3.33	1090	Gravid
Brown Co., Ind.	29 ♀	0.23	71	2.38	308	7.78	458	....
Brown Co., Ind.	33 ♂	0.18	66	2.00	367	10.00	330	In poor condition
Bell Co., Ky.	22 ♀	....	24	1.09	....	6.55	180	....
Morgan Co., Ind.	25 ♀	0.08	27	1.04	338	5.80	231	Fed 2 days before milking. Young born 3 wks. before milking
Brown Co., Ind.	41 ♂	0.29	98	2.39	337	5.80	837	....
Brown Co., Ind.	33 ♂	0.21	74	....	355	7.80	474	Some venom lost during milking

not appreciably changed when rechecked after three months' storage. The copperhead venom samples showed less variation; nevertheless the strongest sample was three times as toxic as the weakest. As determined by intraperitoneal injection, the toxicity of timber rattlesnake venom was slightly greater than that of copperhead venom, the mean LD 50 for the former being 5.11 milligrams per kilo and for the latter 6.36 milligrams per kilo. This difference was confirmed with pooled venom samples that had been stored approximately three years.

On the basis of data at hand, the individual variations in venom toxicity appear to be entirely weakest sample came from a moderately emaciated male copperhead covered with shreds and patches of skin it had been unable to shed; yet the next weakest sample came from a snake of the same size and sex but in excellent condition. The least toxic samples of both copperhead and rattlesnake venom contained the greatest proportionate weight of solids for their respective species; however there does not appear to be sufficient evidence to establish a correlation between a high yield of solids and low venom toxicity.

One may only speculate on which of the snakes in this sample could have delivered a

dose of venom potentially lethal to a human being. Merely expressing the LD 50 in terms of human weight rather than mouse weight is an oversimplification, for the mouse is proportionally quite resistant to pit viper venoms. Moreover, intraperitoneal injection of venom is not normal in snake-bite; and it is doubtful if the quantity of venom injected in an ordinary bite is as great as that obtained by milking. On the other hand, there is every reason to believe that the bite of a snake whose venom contains approximately ten thousand mouse lethal doses per milliliter would be considerably more serious to a human than the bite of a snake whose venom contains only about two thousand doses in the same volume. This limited study indicates that wide and apparently unpredictable individual variation in venom toxicity occurs among copperheads and timber rattlesnakes and probably among other species as well. The possibility of such variation must be considered by physicians treating snake-bite as well as by workers concerned with more academic aspects of venom research.

I wish to express my thanks to H. P. Cottingham, Director of the Fish and Game Division of the Indiana Department of Conservation, who made available to me the copperheads and rattlesnakes collected at Brown County State Park. Margaret Lanahan McAbee and William Overlease, also of the Indiana Department of Conservation, helped greatly in obtaining venom samples from the snakes; and Jeanette Davis, of the Indiana University Medical Center, assisted with the toxicity determinations.

Summary

Individual venom samples were obtained from seven timber rattlesnakes and eight copperheads. The volume and dry weight of each sample was determined and the toxicity measured by intraperitoneal injection of mice.

The larger venom yields, in general, came from the larger snakes; but there were several exceptions. Timber rattlesnakes produced proportionally more venom than copperheads. Copperhead venom contained slightly more solid material per unit volume.

The mean toxicity of timber rattlesnake venom exceeded that of copperhead venom. Wide individual variation was encountered among venom samples from both species and showed no obvious relation to any factor studied.

Literature Cited

Githens, Thomas S. 1935. Studies on the venoms of North American pit vipers. *Jour. Immunology, 29: 165–73.*

——— and I. D. George. 1930. Comparative studies on the venoms of certain rattlesnakes. *Bull Antivenin Inst. Amer., 5: 31–4.*

Reed, L. J., and H. Muench. 1938. A simple method of estimating fifty percent end points. *Amer. Jour. Hygiene, 27: 493–97.*

Department of Microbiology, Indiana University Medical Center, Indianapolis, Indiana.

Hawaiian Shallow-Water Fishes of the Family Brotulidae, with the Description of a New Genus and Notes on Brotulid Anatomy[1]

William A. Gosline

Introduction

THE shallow-water brotulids known from the Hawaiian Islands are here reviewed. Four species are recognized. The first, *Brotula multibarbata*, has been recorded many times from the Islands. The second, *Brotula townsendi*, is resurrected from synonymy, where it has lain, unmolested even by its own describer (Fowler, 1928: 445), for half a century. The third and fourth appear to represent two new species of a new genus and are here described as such.

Though the more numerous, deep-water genera of Brotulidae have been treated three

[1] Contribution No. 39, Hawaii Marine Laboratory.

times (Goode and Bean, 1895: 314; Radcliffe, 1913: 135; and Norman, 1939: 79), the shallow-water forms have not been reviewed since Günther (1862: 371). This failure to revise the inshore brotulids may be attributed to three causes. First, the shallow-water members of the family do not seem to represent a monophyletic group, but rather the offshoots from various branches of the basic, deep-water stock. Consequently, they cannot be treated without reference to the bathyal forms, and these are often unrepresented in the same museum collection with inshore brotulids. Second, most of the shallow-water species seem to live in habitats inadequately sampled by the collector, and many of them are known only from one or a few specimens. Finally, the shallow-water brotulids occur sporadically throughout the tropics and subtropics, and only a small proportion of the genera and species are represented in any one museum.

The present author, like those before him, has only a few of these forms available. Consequently, no competent revision of the group can here be made. Nevertheless, since the family classification of the Brotulidae seems to be based on the osteology of a single species (Regan, 1912: 277), an investigation of the internal characters of the two genera at hand, plus those of a third genus (*Dinematichthys*) kindly made available to me by Dr. L. P. Schultz, has been undertaken. The results are dealt with at the end of the systematic account of the Hawaiian species.

TABLE I

MEASUREMENTS AND COUNTS OF HAWAIIAN SPECIMENS OF *Brotula*

Measurements, other than standard length, given in thousandths of standard length

Species:	*B. townsendi*		*B. multibarbata*	
Locality	Johnston	Hawaii	Hawaii	Hawaii*
Number of specimens	1	1	1	7
Standard length, in mm	130	178	181	274–351
Snout to anal origin	455	475	414	439–461
Depth of body at anal origin	238	224	160	....
Head to tip of opercular flap	238	231	194	198–214
Upper jaw length	118	128	91	94–107
Horizontal eye diameter	38	34	45	38–45
Pupil diameter	23	22	22	....
Snout length	60	56	46	48–56
Fleshy interorbital	52	54	33	32–37
Longest pelvic ray	209	186	171	111–133
Dorsal rays	104	104	126	121–145
Anal rays	77	79	104	100–111
Pectoral rays	23	22	22	24–25
Scales along lateral line	130	126	142	144–181
Scales above lateral line	11	11	10	12–14
Scales below lateral line	30	31	35	36–43

* Data in this column from Hubbs (1944: 173, Table III).

TAXONOMY OF HAWAIIAN SHALLOW-WATER BROTULIDS

As Hubbs (1944: 162) and others have pointed out, there is considerable difficulty in making dorsal and anal fin-ray counts in the genus *Brotula*. The skin at the base of these fins must be slit and reverted to adequately expose the rays. In addition, the vertical fins continue uninterruptedly around the tip of the tail, and the question arises of how many rays to allocate to the caudal fin. The axial skeleton at the base of the posteriormost rays (Fig. 5) does not help to solve this problem,

and it seems best for purposes of enumeration to count all those rays above the midaxis of the tail as dorsal and all those below as anal. Thus, in the present enumerations (Table I) the counts of upper caudal rays given by Hubbs, (1944: 173) and others have been included in the dorsal counts, and the lower caudal rays in the anal. The dorsal and anal counts in *Microbrotula* (Table II) were made in the same way as those for *Brotula*, and for the same reason.

KEY TO THE SPECIES OF HAWAIIAN SHALLOW-WATER BROTULIDS

1a.–Barbels present on snout and chin; each pelvic fin with two rays.

2a.–Eye large, its horizontal diameter greater than or equal to width of fleshy interorbital; width of pupil less than half horizontal diameter of eye; maxillary extending to about level of posterior orbital rim (Fig. 1a); not more than basal third of pectoral fin scaled; vertical fins with a narrow white border, blackish submarginally; lips dark, contrasting strikingly with chin, which is white except at tip.....*Brotula multibarbata.*

2b.–Eye small, its horizontal diameter considerably less than width of fleshy interorbital; width of pupil more than half horizontal diameter of eye; maxillary reaching about an eye diameter beyond eye (Fig. 1b); basal half or two-thirds of pectoral fin scaled; vertical fins in life greenish-brown basally, with a broad orange border; lips and chin uniformly greenish-brown.....*Brotula townsendi.*

1b.–No barbels on head; each pelvic fin of a single filament.

3a.–Dorsal fin originating about over tips of depressed pectorals; head relatively low, its depth at occiput contained about 1¾ times in its length; color translucent red in life, fading to whitish in preservative.....*Microbrotula rubra.*

3b.–Dorsal fin originating about over pectoral axil; head chubby, its depth at occiput contained about 1¼ times in its length; color black.....*Microbrotula nigra.*

Genus *Brotula* Cuvier

TYPE SPECIES.—*Brotula barbata* (Bloch and Schneider).

The species of this genus were revised by Hubbs (1944). Since then *Brotula ordwayi* has been described by Hildebrand and Barton (1949: 25) from Perú. Another species, *B. townsendi*, hitherto placed in synonymy, is here recognized as valid.

Brotula multibarbata Temminck and Schlegel

Figs. 1a, 2a and 5a

Brotula multibarbata Temminck and Schlegel, 1846: 251–53, pl. 111, fig. 2 (Japan); Hubbs, 1944: 170–75 (Phoenix Islands, Dutch East Indies, Philippines, Japan, Hawaii).

Brotula multicirrata Vaillant and Sauvage, 1875: 282 (Hawaii).

Brotula marginalis Jenkins, 1901: 403–04, fig. 16 (Hawaii).

Under one or another of the names in the above synonymy this species has been recorded from Hawaii many times. It has recently been treated in detail by Hubbs (1944), and I follow him in synonymizing two of the three species of *Brotula* described from Hawaii with Temminck and Schlegel's form from Japan.

B. multibarbata is quite common in certain areas around Oahu in water as shallow as 6 feet deep. It seems to prefer, by day at least, dead reefs in which holes and passageways have been eroded. The largest specimen that has come to my attention was about 18 inches long. A 14-inch female taken in June was ripe, but smaller specimens collected with it were not.

TABLE II

MEASUREMENTS AND COUNTS OF TWO SPECIES OF *Microbrotula*

Measurements, other than standard length, in thousandths of standard length. For paratypes of *M. nigra*, ranges and, in parentheses, means are given.

Measurement or count	*M. rubra*		*M. nigra*
	Holotype	5 Paratypes	Holotype
Standard length, mm.	38.3	32.0–46.2 (37.3)	62.5
Snout to anal origin	493	494–525 (510)	495
Snout to dorsal origin	444	445–469 (453)	331
Snout to pelvic insertion	243	231–247 (239)	225
Body depth at anal origin	162	166–179 (172)	237
Head length*	269	260–284 (273)	275
Upper jaw length	131	123–139 (132)	138
Eye diameter	26	24–31 (28)	45
Snout length	76	72–79 (77)	86
Interorbital width (fleshy)	70	61–68 (65)	110
Pelvic filament length	128	132–137 (134)†	200
Dorsal rays	89	81–92 (88)‡	90§
Anal rays	78	72–80 (76)‡	50§
Pectoral rays	12	12–14 (13)	20§

* Measured to tip of opercular flap.

† Based on three specimens.

‡ Based on four specimens.

§ The rays in all the fins of this species are extremely hard to count, and the enumerations given are only approximate.

Brotula townsendi Fowler

Fig. 1b

Brotula townsendi Fowler, 1900: 518–19, pl. 20, fig. 3 (Hawaii).

This species has unanimously been treated as a synonym since its original description. My first experience with it was at Johnston Island (Lat. 16° 44′ N., Long. 169° 17′ W.) where one specimen of this species represented the only brotulid taken. The marked difference in coloration between this specimen and *B. multibarbata* was noted in the field. A second example was recently taken in a rotenone station on Oahu from among numerous specimens of *B. multibarbata*. Again the specimen was brought in because of its different coloration.

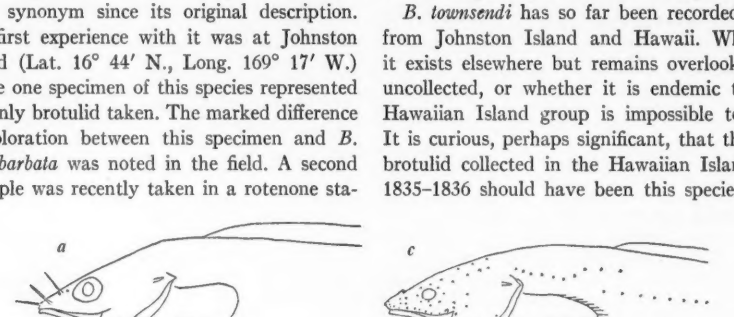


Fig. 1. a, *Brotula multibarbata*, from a specimen 185 mm. in standard length. b, *Brotula townsendi*, 128 mm. c, *Microbrotula rubra*, paratype, 37.5 mm. (except that the length of an unbroken pelvic filament is shown). d, *Microbrotula nigra*, holotype, 62.5 mm.

B. townsendi is a somewhat chunkier fish than *B. multibarbata*, with a smaller eye, a larger mouth (Fig. 1b), fewer vertical fin rays (Table I), and different coloration. In all these characters, the specimens at hand agree with Fowler's original description and figure.

Further comparative data between *B. townsendi* and *B. multibarbata* are given in Table I.

The color of the fresh specimen from Oahu was as follows. Lips and upper head greenish-brown; belly greenish-yellow; rear of body orange-brown; barbels on upper jaw brownish at base with orange-red tips; those on chin, yellow at base with orange tips; pelvic filaments pink at base, yellowish-white centrally, with about the outermost one-sixth yellowish-orange; dorsal fin greenish-chestnut along base, with a broad orange border, which becomes less marked posteriorly; anal similar to dorsal in coloration, except that the base of the fin in front is greenish-yellow. There are no abrupt color changes anywhere on the body or head.

B. townsendi has so far been recorded only from Johnston Island and Hawaii. Whether it exists elsewhere but remains overlooked or uncollected, or whether it is endemic to the Hawaiian Island group is impossible to say. It is curious, perhaps significant, that the one brotulid collected in the Hawaiian Islands in 1835–1836 should have been this species.

B. townsendi does not seem to be closely related to any species of the genus yet described, differing immediately from all others in most of the characters given in the key.

Genus ***Microbrotula***, gen. nov.

TYPE SPECIES.—***Microbrotula rubra***, sp. nov.

Body ending in a point posteriorly, covered with roundish, embedded scales. Visible portion of lateral line consisting of raised papillae in two unconnected sections, the anterior running high, from the gill cover about to the anus, the posterior following the midaxis from the anus to somewhat short of the hind end of body. Vertical fins continuous around the tip of tail. A copulatory organ present in males (of *M. rubra*). Pyloric caeca essentially absent, though a very short, broad, flap-like projection of skin is present at the pylorus (in *M. rubra*).

Pelvic fins each of a single filament, originating slightly behind the preopercular border.

Head more or less covered with papillae similar to those of the lateral line and with embedded scales (not visible externally) on the cheeks, opercles, and top of head. No barbels. Anterior nasal opening in a short tube. Eyes present, small and round. Maxillary with a downwardly-projecting point on its posteroventral angle. Preopercular border free below, without spines. A strong, though largely concealed, spine on the opercle. Two well-formed gillrakers on the lower half of the first arch and another at the angle, the rest reduced to spiny knobs.

Certain other internal characters of *Microbrotula rubra* are discussed in the anatomical section of this paper.

As has already been noted, the interrelationships between the various shallow-water genera of brotulids remain little known. It is impossible with the material at hand to remedy this matter, and the following artificial key is provided merely as a means of distinguishing *Microbrotula* from other shallow-water genera of the family.[2]

1a.–Dorsal and anal separated from the caudal by an interspace.....*Dinematichthys, Brosmophycis, Dermatopsis, Monothrix, Ogilbia, Bidenichthys, Typhliasina, Calcarbrotula* and *Brotulina.*
1b.–Dorsal and anal more or less continuous with the caudal.
2a.–Pelvics inserted ahead of or under eyes .....*Sirembo*[3] and *Hoplobrotula.*[3]
2b.–Pelvics inserted behind eyes.
3a.–Snout and chin with elongate barbels .....*Brotula.*
3b.–Snout and chin without elongate barbels, though patches of cilia may be present.
4a.–Eyes rudimentary or absent..... .....*Lucifuga, Stygicola* and *Dipulus.*
4b.–Eyes well developed, though usually small.
5a.–Opercle without a spine; pelvic filaments bifid..... *Petrotyx, Eutyx* and *Pseudobythites.*
5b.–Opercle with a well-developed spine; pelvics each of a simple filament.....*Microbrotula.*

As regards deep-water genera, *Microbrotula* comes out to *Cataetyx* in the keys provided by Norman (1939: 83). Indeed, *Microbrotula* seems to be a dwarfed, shallow-water offshoot of a *Cataetyx*-like fish. It differs at once from *Cataetyx* in the larger, more deeply embedded scales and in the (for brotulids) reduced number of pectoral rays.

Derivation: *Micro* (Gr.) = little + *Brotula*, the genus from which the family name is derived.

Microbrotula rubra, sp. nov.

Figs. 1c, 4a and b, 5b

HOLOTYPE.—U.S.N.M. No. 162710, a male, 38.3 mm. in standard length, taken in a rotenone station in about 3 feet of water over an area of mixed coral and sand in Kaneohe Bay, on the north coast of Oahu, Hawaiian Islands, October 2, 1948, by Gosline and class.

PARATYPES.—U.S.N.M. No. 162711, a female, 32.0 mm. long, with the same data as the holotype; University of Hawaii No. 35, 2 males, 36.5 and 34.2 mm., with the same data as the holotype; University of Hawaii No. 98, 2 females, 46.2 and 37.5 mm., from a slightly different area in Kaneohe Bay, Oahu, Nov. 11, 1948, Gosline, Hiatt, Brock, Moore and Woodworth. The smaller of the last two specimens has been skeletonized.

A relatively trim and elongate fish (as compared with *Microbrotula nigra*, described below), the greatest depth of body entering the standard length about 6 times. Snout depressed; postorbital portion of head roundish in cross section; body behind anus distinctly compressed. Dorsal profile sloping gently upward from tip of snout to origin of dorsal, which lies about over tips of pectorals.

Head covered with very obvious, scattered papillae except on the lips, maxillaries, and the flesh between the rami of the lower jaw. Scattered openings to the lateral line system on the lower portion of head; of these the most prominent, never larger than the eye, are located as follows: 1 on snout rim (on each side), 1 in cheek just above and ahead of posterior end of maxillary, 1 in preopercular border, and about 3 in the ramus of lower jaw. From the symphysis of lower jaw a low, fleshy ridge, bifurcated at its posterior tip, projects downward and backward across the jaw surface. Head scales completely buried in flesh and in-

[2] The Australian genus *Othos*, included in the Brotulidae by Norman (1939: 80), does not belong in this family. According to Castelnau's original description it has five ventral rays, and spines in the dorsal and anal.

[3] These genera are included here because they are listed as doubtfully deep-water forms by Norman (1939: 84). That they are true deep-water species is shown by Kamohara (1952: 91).

visible from the exterior. Anterior nostril with a tube that projects beyond snout rim; posterior nostril a rather large, roundish, backwardly facing hole with a raised anterior rim; area between the two nostrils of each side marked by a slightly raised ridge. Eye covered with flesh which, in preservative, is opaque and undifferentiated from that of the surrounding area, the eye appearing through this as a small, round, black bead. Teeth many-rowed in the jaws and on roof of mouth; those on the palatines, laterally on the vomer, on the front of the premaxillary, and of the inner row of the posterior portion of the dentary enlarged, sharp, and conical. Between the lateral patches on the vomer is a median area of small granular teeth under which the tongue projects.

Dorsal, anal, and caudal fins indistinguishably united into a single fin, the posteriormost rays of which are little exserted beyond the others. Body scales covered with flesh and not visible superficially; judging from the size of a few exposed scales there are about 60 in a longitudinal series. The front section of the lateral line runs back a short way from just above the opercular spine, then jogs upward, continuing along this upper level to nearly below dorsal origin; the posterior section begins below the last papilla of the upper line and continues back along the mid-sides, gradually disappearing on the posterior third of body. Pectoral narrow-based, the tips of its rays free and flexible. Pelvic filaments extending about half way from their origins to anus. Copulatory apparatus of males about as in *Dinematichthys* (Turner, 1946).

Color in life uniform translucent pinkish-red, fading to whitish in preservative.

Certain counts and measurements of this species are given in Table II. That the specimens at hand are adult is shown by the fact that a 37.5-mm. female had about 50 to 80 large eggs in each ovary.

Derivation: *rubra* (L.) = red.

Microbrotula nigra, sp. nov.

Holotype.—University of Hawaii No. 1684, a gravid female, 62.5 mm. in standard length taken in a rotenone station off the Waikiki reef, Oahu, in about 30 feet of water on Dec. 31, 1952, by Gosline and party.

A relatively short, chubby species with a blunt, globular head, the greatest depth entering the standard length about 3½ times. Dorsal profile strongly convex, rising to the dorsal origin, which lies about over pectoral axil.

Head with a few scattered and not very prominent papillae. Lateral-line openings on the head of various sizes; the two largest are elongate slits nearly an eye diameter in length; 1 on the preopercular border and 1, bridged by a median frenum, on the snout rim; a prominent pore on either side of the symphysis of the lower jaw. Head scales embedded in the skin and invisible superficially. Anterior nostril in a short, broad tube; posterior nostril a gaping hole without raised rim just ahead of eye. Eye covered with transparent flesh which is well differentiated from that of the surrounding area, round, far forward on head. Maxillary extending about two eye diameters beyond eye. Teeth all minute and granular, in bands on the jaws, vomer, and palatines. Vomerine teeth in two lateral patches between which the tongue extends.

Dorsal, anal, and caudal fins merging indistinguishably as in *M. rubra*, but with the terminal rays notably prolonged. Body scales embedded and only faintly visible through the skin, roughly 50 in a longitudinal series. The front section of the lateral line series rises from above the opercular spine, runs longitudinally, and dips slightly before terminating above the anus; lower lateral line running from the anus along mid-sides as in *M. rubra*. Pectoral base with a distinct fleshy sheath that extends out about half the length of the fin; tips of pectoral rays weak and silky but apparently bound to one another by a very frail membrane. Pelvic filaments extending about ⅔ the distance from their bases to the anus.

Head and body brownish-black; fins black.

Certain counts and measurements of this species are given in Table II. The gravid condition of the holotype denotes its maturity.

Derivation: *nigra* (L.) = black.

The differences in general appearance and morphological characters between this species and *M. rubra* are so great that the question arises of whether the two species are congeneric. They are, however, in my opinion more closely related to each other than to any other described brotulid, and to create two genera for them at the present time would, I believe, defeat more purposes than it would serve.

Notes on Brotulid Anatomy

The anatomy of the brotulid fishes appears to be little known. The most complete accounts that I have been able to find are those by Poey (1856–1858: 95–102) for the blind brotulids of Cuba and by Regan (1912: 277) for *Brotula*. Regan used the osteology of *Brotula* as the basis for his definition of the family.

Early workers, e.g., Günther (1862: 371), placed the brotulids with the cods and macrourids. However, Regan (1903) and others have shown that the resemblances between these groups are secondary and that actually (Regan, 1912) the brotulids belong among the perch-like fishes far from the cods. Svetovidov's fine, recent monograph of the cods of Russia (1948) corroborates Regan's views. Nevertheless the resemblances between the cod-like fishes and the brotulids remain striking.

Svetovidov (1948: 13) noted that one of the primary characters by which the cods have been separated from other groups is that the olfactory nerves do not pass through the orbits but lie between them in a canal which is essentially a forward extension of the cranial cavity. Goodrich (1909: 478) stated that this feature was found among teleosts only in the Gadidae, Galaxiidae, and Cyprinidae. Svetovidov however (1948: 14) has shown that this forward extension of the cranial cavity occurs in several other groups, both higher and lower in the phylogenetic sequence than the cods, including some blennies and brotulids.

In *Brotula* the eyes are relatively large, and there is a median, interorbital septum that is largely membranous (Fig. 2a). However, the frontals send down a flange from above, and within this the elongate, olfactory nerves lie adjacent to one another for most of their length. They appear to be completely enclosed in a median bony canal as in certain cods (Moridae, see Svetovidov, 1948: 16). In *Dinematichthys* and *Microbrotula* the situation is quite different. There is no median interorbital septum in these small-eyed forms, and the cranial cavity itself extends forward as a broad tube between the eyes almost to the mesethmoid. The olfactory nerves in *Dinematichthys* are short and diverge immediately (Fig. 2b). In this fish the forward extension of the cranial cavity is protected on the sides in large part by lateral flanges of the parasphenoid, which form a trough around it (Figs. 3a and b), though in *Microbrotula* (Fig. 4a) the lateral walls are largely membranous. Consequently, when the interorbital membranes of these two genera are removed they do not leave a median opening through the skull, but rather a pair of openings leading into the cranial cavity.

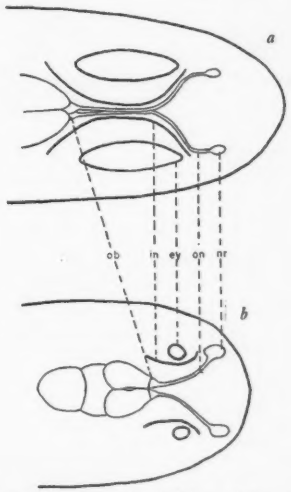


Fig. 2. Diagrammatic sketches of fore-parts of heads of (a) *Brotula multibarbata* and (b) *Dinematichthys iluocoeteoides*. *ey*, outline of eye as seen externally; *in*, lateral border of cranium at the level of the olfactory nerves; *ob*, olfactory bulb; *on*, olfactory nerve; and *nr*, outline of nasal rosette.

The olfactory nerves themselves differ in one important respect from those of the cods. In *Brotula* and *Dinematichthys* the olfactory bulbs (Fig. 2) lie at the front of the brain as in most other fishes. In the adult cods the olfactory bulbs lie near the nasal rosette and are connected with the brain by long olfactory stalks. However, this peculiarity of the cods is considered to be a secondary specialization, and does not occur in the macrourids (Svetovidov, 1948: 15).

In the cods there is a greatly expanded auditory bulla, the lateral surface of which is made up to a considerable extent by the opisthotic. The glossopharyngeal perforates that bone. Svetovidov considers the position of the glossopharyngeal opening in the cod-like fishes to be unique to this group. However, Emery (1880, pl. 3, figs. 20, 29 and 30) indicates a

foramen for the glossopharyngeal in the opisthotic of the carapid "*Fierasfer acus*" and of the goby "*Gobius capito*" as well as in the gadid "*Brosmius brosme.*" In *Dinematichthys*, which has the opisthotic expanded as in "*Fierasfer*"

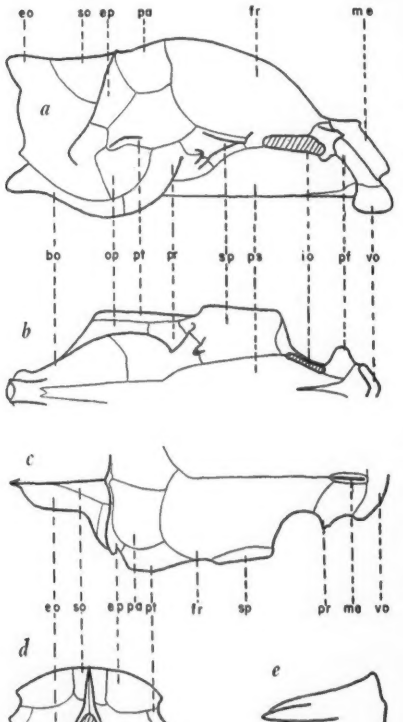


Fig. 3. Head bones of *Dinematichthys iluocoeteoides*, based on a cranium 8 mm. long. a, Lateral view of cranium. b, Left half from below. c, Right half from above. d, Posterior view. e, Operculum. *bo*, basioccipital; *eo*, exoccipital; *ep*, epiotic; *fr*, frontal; *io*, orbital opening; *me*, mesethmoid; *op*, opisthotic; *pa*, parietal; *pf*, prefrontal; *pr*, prootic; *ps*, parasphenoid; *pt*, pterotic; *so*, supraoccipital; *sp*, sphenotic (plus alisphenoid?); and *vo*, vomer.

and in gadids, the glossopharyngeal foramen appears to lie in the exoccipital, as it does in *Brotula*, in which the opisthotic is not expanded. I have also examined the skull of a Hawaiian goby, *Awaous stamineus*, and find the glossopharyngeal foramen in the exoccipital there as well.

Regan (1912: 265) originally placed the brotulids in his suborder Blennioidea, but later erected a separate suborder Ophidioidea (1929: 320) for the brotulids, ophidiids, and carapids (or fierasferids). For both the Blennioidea and the Ophidioidea Regan gave the union of the frontals and the parasphenoid as one of the few diagnostic characters. Svetovidov (1948) demonstrated how variable this feature is among cods; Clark Hubbs (1952: 48) has shown that it breaks down in Regan's Blennioidea; and of the three brotulid genera examined, the parasphenoid and the frontals meet in *Brotula* and *Dinematichthys*, (Fig. 3a) but not in *Microbrotula* (Fig. 4a).

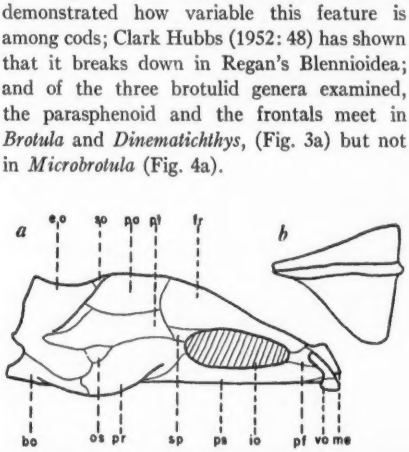


Fig. 4. Head bones of *Microbrotula nigra*, based on a cranium 7 mm. long. a, Lateral view of cranium. b, Operculum. Abbreviations as in Fig. 3.

Another feature used by Regan to characterize the Ophidioidea (1912: 277) is the V-shaped operculum. This character holds well for *Brotula* (Regan, 1912: 269, fig. 2a), rather imperfectly for *Dinematichthys* (Fig. 3e), and not at all for *Microbrotula* (Fig. 4b).

Within his Ophidioidea, one of the features used by Regan (1914: 20) for separating the Brotulidae from the Ophidiidae is the division of the parietals by the supraoccipital in the Brotulidae and the union of the parietals along the mid-dorsal line in the Ophidiidae. In the three brotulids examined here, the supraoccipital lies between the parietals in *Brotula* and *Microbrotula*, but the parietals meet along the mid-dorsal line in *Dinematichthys* (Fig. 3c).

All of the internal features mentioned thus far blur the distinctiveness between the Brotulidae or its suborder, as originally defined, and other fish groups. It is only natural, however, that as more members of any group are investigated, parts of any original diagnoses based on a few specimens should prove invalid.

Despite the invalidations in the present instance, I have no evidence that the relationships of either the Ophidioidea or the Brotulidae are other than those assigned to them by Regan. Without much doubt, however, some of the characters Radcliffe (1913: 136–38) divided brotulid genera into several subfamilies. However, Norman (1939: 80) considered his own later arrangements of genera tentative and did not recognize subfamilies. The notes that follow

TABLE III

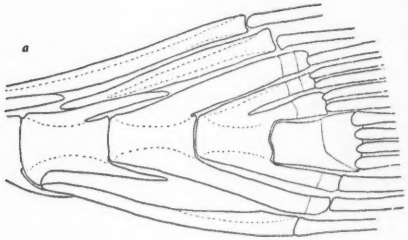
MORPHOLOGICAL CHARACTERS OF THREE BROTULID GENERA

Character	*Brotula*	*Dinematichthys*	*Microbrotula*
Scales	Ovate, with an eccentric axis	Round, with a central axis	Round, with a central axis
Copulatory organ	Absent	Present in males	Present in males
Air bladder	Divided into two sections	Simple, in a single section	Simple, in a single section
Pyloric caeca	Three	None	None
Olfactory nerves	Long, running adjacent to one another for much of length	Short, immediately diverging	(Character not investigated)
Cranial cavity	Pinched off between the orbits	Extending forward between the orbits almost to the mesethmoid	As in *Dinematichthys*
Interorbital opening	Large, median, not restricted below by flanges of the parasphenoid	Small, lateral, restricted below by flanges of the parasphenoid	Moderate, lateral, little restricted by flanges of the parasphenoid
Parasphenoid	In contact with the frontals	In contact with the frontals	Not in contact with the frontals
Alisphenoids	Present, small but well-demarcated	Apparently either absent or ankylosed with the sphenotics	As in *Dinematichthys*
Opisthotic	Small, forming a very slight part of the auditory bulla, the exoccipital meeting the prootic below it	Expanded out onto the auditory bulla, separating the exoccipital from the prootic	As in *Brotula*
Parietals	Separated by the supraoccipital	Overlapping one another on the middorsal line	As in *Brotula*
Exoccipital condyles	Meeting above the basioccipital	Not meeting above the basioccipital	As in *Dinematichthys*
Suspensorium	As figured by Regan (1912: 269)	About as in *Brotula*	About as in *Brotula*
Jaws	As figured by Regan (1912: 269)	About as in *Brotula*	About as in *Brotula*
Operculum	V-shaped	More or less scimitar-shaped	Of normal percoid type
Gill arch system	Branchiostegal rays 8; gillrakers: 2 below and another at angle	Branchiostegal rays 7; gillrakers as in *Brotula*	Branchiostegal rays 7; gillrakers as in *Brotula*
Vertebral column	Vertebrae 15 + 40 according to Regan (1912: 278); hypural fan reduced	Vertebrae 12 + 31; hypural fan percoid	Vertebrae 11 + 41; hypural fan reduced

genera now allocated to the Brotulidae do not belong there, and the limits between the Brotulidae and the Ophidiidae seem to be badly in need of reinvestigation.

Within the Brotulidae the classification of genera has been erected almost entirely on the basis of external characters. By means of such bear out Norman's inference that much remains to be learned about the phylogenetic interrelationships of brotulid genera and that subfamily recognition is probably premature. Norman (1939) divided the deep-water genera into some five groups, and the shallow-water forms presumably fall within these groups.

In this classification *Brotula* stands by itself, and *Dinematichthys* and *Microbrotula* fall within the viviparous group. Yet the internal differences between *Dinematichthys* and *Microbrotula* are about as great as between either of these genera and *Brotula* (Table III). Furthermore, each of these genera show a combination of what seem to be primitive and specialized characters.



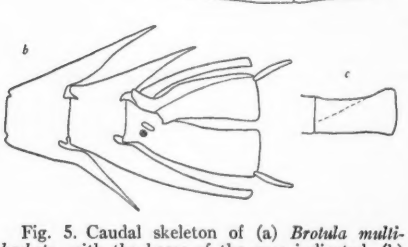


Fig. 5. Caudal skeleton of (a) *Brotula multibarbata*, with the bases of the rays indicated, (b) *Dinematichthys iluocoeteoides*, with only the outermost rays shown, and (c) *Microbrotula nigra*, with only the last two vertebrae indicated.

In the caudal fin, *Dinematichthys* seems to show a generalized structure for the family. It has 17 caudal rays, of which 15 are branched, and the supporting skeleton is typically percoid (Fig. 5b). The caudal structure of *Brotula* (Fig. 5a) and *Microbrotula* (Fig. 5c) is much more specialized (or degenerate); in these genera the vertical fins are continuous around the posterior end of the body, there are only 4 fin rays articulating with the last vertebra, and their supporting skeleton is reduced. In dissecting *Microbrotula* it was noted that air bubbles could be expressed through the vertebral column and out the last vertebra. In the last vertebra such bubbles passed through the center of the base, then upward and out along the upper surface of the plate supporting the four terminal fin rays. From this observation, and in the absence of other evidence, the final vertebra of *Microbrotula* (and *Brotula*) might be interpreted in two ways. Either (and I think preferably) the last vertebra represents the urostylar vertebra and the plate attached to it is a reduced hypural fan, or the urostylar vertebra has been lost and a pseudo-hypural fan has been developed from the haemal arch of a more anterior vertebra. That intermediate conditions between those of *Dinematichthys* and those of *Microbrotula* and *Brotula* occur in the family is indicated by D'Ancona's (1939: 170) figures of the caudal skeleton of *Pteridium armatum* and *P. atrum*.

In other internal characters the three genera investigated are equally diverse. The differences in the interorbital region have already been noted. Here, it is *Brotula* that appears to represent the generalized conditions of the family.

Again, as already noted, the parietals are separated by the supraoccipital in two of the genera, but meet along the mid-dorsal line in *Dinematichthys*. In this character *Dinematichthys* appears to be the specialized form.

In *Dinematichthys* and *Microbrotula* the air bladder is elongate, simple, and one-celled. In *Brotula* it is separated into two parts by a constriction, and the anterior segment has a large gland on either side of it.

Finally, the males of *Dinematichthys* and *Microbrotula* have a rather complicated copulatory apparatus and the females are presumably viviparous. *Brotula* lacks the copulatory organ and is oviparous. However, whether oviparity or viviparity is primitive for the family is not clear. At least, many of the members of the presumably related blennioid fishes are also viviparous.

The above account and Table III indicate the great variability in internal characters to be found within the Brotulidae. These differences more than justify the separation of *Brotula* from the other two genera as a separate subfamily, as has generally been done, but if *Brotula* is so separated the question arises as to whether *Dinematichthys* and *Microbrotula* should be placed together in the same subfamily. Only a more thorough knowledge of other brotulid genera can answer this question.

That the Brotulidae should be very variable is consistent with their wide bathymetric and geographic range. From the viewpoint of environmental adaptation alone this family de-

serves more anatomical study than it appears to have yet received.

Literature Cited

D'Ancona, Umberto. 1939. Note di ittiologia mediterranea. III. Pteridium atrum (Risso) e P. armatum Doderlein. *Pubblicazione della Stazione Zoologica di Napoli, 17 (2): 159–73, 8 figs.*

Emery, Carlo. 1880. Le specie del genere Fierasfer nel Golfo di Napoli e regione limitrofe. *Fauna und Flora des Golfes von Neapel. II. Monographie. 1–76, 9 pls.*

Fowler, Henry W. 1900. Contributions to the ichthyology of the tropical Pacific. *Proc. Acad. Nat. Sci. Phila., (3): 493–528, pls. 18–20.*

——— 1928. The fishes of Oceania. *Mem. Bernice P. Bishop Mus., 10: i–iii + 1–540, 49 pls.*

Goode, George Brown, and Tarleton H. Bean. 1895. Oceanic ichthyology. *U. S. Nat. Mus., Special Bull. 2: xxxv + 553* and atlas of pp. xxiii + 26, pls. 1–123.

Goodrich, E. S. 1909. Vertebrata Craniata. Part IX in "A Treatise on Zoology", edited by E. Ray Lankester. *Adam and Charles Black, London: xvi + 518, 514 figs.*

Günther, Albert. 1862. Catalogue of the fishes in the British Museum. IV. *British Museum, London: xxii + 534.*

Hildebrand, Samuel F., and Otis Barton. 1949. A collection of fishes from Talara, Perú. *Smithsonian Misc. Coll., 111 (10): 1–36, 9 figs.*

Hubbs, Carl L. 1944. Species of the circumtropical fish genus *Brotula*. Copeia, (3): *162–78, 2 figs.*

Hubbs, Clark. 1952. A contribution to the classification of the blennioid fishes of the family Clinidae, with a partial revision of the Eastern Pacific forms. *Stanford Ich. Bull., 4 (2): 41–165, 64 figs.*

Jenkins, Oliver P. 1901. Descriptions of fifteen new species of fishes from the Hawaiian Islands. *Bull. U. S. Fish Comm., 19 (1899): 387–404, 16 figs.*

Kamohara, Toshiji. 1952. Revised descriptions of the offshore bottom fishes of Prov. Tosa, Shikoku, Japan. *Repts. Kôchi Univ., Nat. Sci., 3: 1–122, 100 figs.*

Norman, J. R. 1939. Fishes. *The John Murray Expedition, 1933–1934, Sci. Repts., 7 (1): 1–116, 41 figs.*

Poey, Felipe. 1858–1860. Peces ciegos de la isla de Cuba, comparados con algumas especies de destinto genero. *Memorias sobre la Historia Natural de la Isla de Cuba: 95–114, pls. 9–11.*

Radcliffe, Lewis R. 1913. Descriptions of seven new genera and thirty one new species of fishes of the families Brotulidae and Carapidae from the Philippine Islands and the Dutch East Indies. *Proc. U. S. Nat. Mus., 44: 135–76, pls. 7–17.*

Regan, C. T. 1903. On the systematic position and classification of the gadoid or anacanthine fishes. *Ann. Mag. Nat. Hist., ser. 7, 11: 459–66, 2 figs.*

——— 1912. The classification of the blennioid fishes. *Ibid., ser. 8, 10: 265–80, 4 figs.*

——— 1914. Fishes. *British Antarctic* ("Terra Nova") *Expedition, 1910, Natural History Repts., Zool., 1: 1–54, 13 pls.*

——— 1929. Fishes. *Encyclopaedia Britannica, 14th ed., 9: 305–28.*

Svetovidov, A. N. 1948. The cods. *Fauna of the USSR, Fishes, 9 (4): 1–221, 72 pls. (In Russian.)*

Temminck, C. J., and H. Schlegel. 1842–1850. Pisces. *Fauna Japonica. Leiden, 1–324, pls. 1–143 + A.*

Turner, C. L. 1946. Male secondary sexual characters of *Dinematichthys iluocoeteoides*. Copeia *(2): 92–96, 1 pl.*

Vaillant, L., and H. E. Sauvage. 1875. Note sur quelques espèces nouvelles de poissons des Iles Sandwich. *Rev. Mag. Zool., 38 (vol. 3 of ser. 3): 278–87.*

Department of Zoology and Entomology, University of Hawaii, Honolulu, T. H.

Distribution, Morphology and Life History of *Lampetra aepyptera*, a Brook Lamprey, in Maryland[1]

Herbert F. Seversmith

Distribution

THE holotype of *Lampetra aepyptera* (Abbott) is said to have come from Portsmouth, Ohio, several years before 1860, and it is deposited in the Academy of Natural Sciences in Philadelphia. What appears to be the same species of lamprey has been found in Bear Branch (= Laurel Run) or closely collateral tributaries of the Patuxent River, since April 9, 1888 (USNM No. 39570). The same lamprey has been collected in this locality for several decades (USNM Nos. 49136, 73882 (Crow Branch), 93870, 106583 and 143897–98). Specimens in the National Museum include also those from Paint Branch (likewise tributary to the Patuxent River) north of College Park, Maryland (No. 143899); from a tributary of the Rappahannock River near Fredericksburg, Virginia; from Suitland, Maryland;

[1] This paper is part of the thesis submitted to the Faculty of the Graduate School of the University of Maryland in partial fulfillment of the requirements for the Ph.D. degree.

and from runs near Annapolis, Maryland (see Raney, 1941: 419, for more details).

Raney (1941) also found *L. aepyptera* in a small tributary of the Neuse River system in North Carolina, on April 6, 1940. Subsequently Bayliff (1942, and personally to the writer, 1951) studied specimens of what appeared to be this lamprey taken from a small tributary of the North River, parallel to Rutland Road at its junction with U. S. Highway 50, near Annapolis, Maryland. (See also Vladykov, 1950: 77.) Mr. Romeo Mansueti told me that he collected *L. aepyptera* in Chambers Lake at Federalsburg, Maryland on October 26, 1950 (specimens now at Univ. of Michigan, No. 160744).

Beginning in 1950 and through 1952 I collected about 450 specimens (approximately 75 adults and 375 ammocoetes) of a brook lamprey in Crow Branch and Bear Branch, about one and one-half miles southwest of Laurel, Maryland. Bear Branch now flows into the artificially created Laurel Lake. The outlet of Laurel Lake is a spillway adjacent to a dam and about fifty yards west of U. S. Highway 1. The overflow from the lake forms a brook which passes under the foregoing highway and its waters are joined by Crow Branch at a crossing of the Baltimore and Ohio Railroad, about one-fourth of a mile east of the highway. The drainage is tributary to the Patuxent River.

Over a mile of each of these branches in the wooded region west of the highway has been explored systematically. The water movement is slow in the deeper parts of these streams, but is faster over riffles. The bottoms are chiefly fine gravel in quiet sections, with coarse gravel at the bottom of fast-running water. The bottoms of pools (about three to four feet deep) consist of fine sand, and backwater areas have fine sand overlaying decomposing organic material. Both brooks appear to be free of pollution in the area explored; algae, protozoa and insect larvae are found in abundance.

The Maryland brook lamprey was called *Lampetra* (*Okkelbergia*) *lamottenii* by Creaser and Hubbs (1922: 8, 14, pl. 1) but was subsequently referred to as *Lampetra aepyptera* by Hubbs and Trautman (1937: 23–24) and has also been named *Eudontomyzon aepypterus* (as by Mansueti, 1951: 302). A critical comparison of populations of *Lampetra aepyptera* throughout its range is needed to firmly establish the status of the Maryland stocks. Both Raney (1952: 98) and Cook (1952: 268), in recording this species from Georgia and Mississippi, respectively, have indicated that *aepyptera* may be divisible into subspecies. In the present paper, I follow current nomenclature in referring to the Maryland form as *Lampetra aepyptera*, but I am not convinced that this classification is correct.

Morphology

General characteristics.—The adult brook lamprey (Figs. 1 and 2) is a slender, eel-like animal which swims agilely in clear,

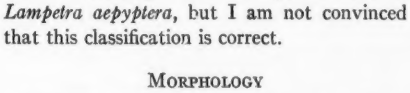


Fig. 1. Adult male brook lamprey (considered to be *Lampetra aepyptera*), 102 mm. total length, from Bear Branch, Maryland.

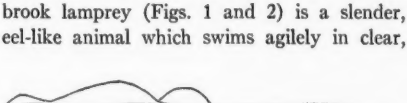


Fig. 2. Adult female brook lamprey (considered to be *Lampetra aepyptera*), 92 mm. total length, from Bear Branch, Maryland.

freshwater brooks. It is dark gray-brown to buff dorsally, and white to very light salmon-buff ventrally and over the gill-openings. It may grow to 130 mm. (about 5 inches) in total length and 10 mm. (about 3/16 inch) in body height. It has a roughly circular sucking mouth by which it characteristically attaches to the substrate.

There is a distinctive, diamond-shaped caudal fin. The male has the long gonoducal papilla characteristic of the genus, and it has a larger buccal cone than the female, with coarser fimbriae and teeth.

Dimensions.—No extensive data on the total length of the adult or metamorphosing lamprey have been published. Measurements (Table I) made upon relaxed animals in chloretone water show that the metamorphosing animals have undergone an average shortening of 3.4 percent (1.2 percent for males, 4.6 for females, 3.4 for both sexes) upon attainment of the adult state. The change from larval form begins internally about October 15 and externally

about February 1 of the following year, at the 39th parallel.

There is considerable variation in the lengths of individual animals. One maturing female caught during this period was 130 mm. in overall length. At the same time there was maintained in the laboratory another female which had been caught as a larva on October 13, 1951, and which at its death on March 17, 1952 was far advanced in metamorphosis. Because of its over-winter environment in the aquarium, this relatively unfed animal was only 82 mm. long on March 1, 1952. It appears, therefore, that the growth of the late larva is significantly dependant upon ecological conditions, particularly the availability of food.

TABLE I

TOTAL LENGTHS, IN MILLIMETERS, OF ADULT AND METAMORPHOSING STAGES OF THE BROOK LAMPREY IN MARYLAND

Stage of development	Number	Minimum	Maximum	Average
Adults				
Male	12	93.0	120.0	103.8
Female	10	90.0	119.0	103.6
Both sexes	22	...	...	103.7
Metamorphosing animals				
Male	8	90.0	125.5	105.1
Female	20	93.0	130.0	108.6
Both sexes	28	...	...	107.4

MYOMERE COUNT.—One of the criteria used to separate species of lampreys is the average number of muscle segments which may be counted from the seventh (most posterior) gill-opening to the beginning of the cloaca (Hubbs and Trautman, 1937). This count has been given by Fowler (1907) to be about 53 in *L. aepyptera*, and counts for the late larva averaged 54 (Vladykov, 1950). Forty adults and fifteen late larvae counted by me (Table II) show that the average myomere count is 56.6. I found the holotype of *L. aepyptera* to have 57 myomeres. In making such counts it has been borne in mind that ventrally the muscle segments are reflexed anterad, and those immediately in front of the cloaca are strongly compressed. Consequently the more lateral, wider part of the last three or four myomeres may seem to be located posterior to the beginning of the vent.

COLORATION.—The coloration of the adult lamprey is derived from at least four sources: (1) Stellate melanophores, capable of changing considerably in size. These are disposed in a single layer just below the somewhat transparent epidermis, and are greatest in number in the dorsal midline. They may extend in patches on the ventroposterior part of the animal, giving it a piebald appearance. Anteroventrally, there are few melanophores. In many animals the melanophores are surrounded by other cells whose cytoplasm is filled with a finely distributed, deep-brown pigment, which gives the area a very even, deep color. (2)

TABLE II

MYOMERE COUNTS IN THE MARYLAND BROOK LAMPREY

Number of myomeres	Number of adults	Number of late larvae (>100 mm.)	Total
53	1	..	1
54	..	..	..
55	7	3	10
56	8	4	12
57	19	7	26
58	2	..	2
59	1	..	1
60	2	1	3

Very small cellular inclusions which reflect a coppery sheen. These are extremely minute and more or less evenly distributed in the cells just under the epidermis. (3) Ventrally, the glistening white of the belly is caused by numerous microscopic, scale-like cell inclusions, which appear to be similar to those occurring, for example, in the epidermis of the herrings. The whitening of the venter is an indication of maturity; this is reinforced when the skin around the gill-openings likewise becomes quite pale. (4) The bluish tone arising from the breaking up of light in the imperfectly transparent epidermis, which modifies the brown coloration. This contributes to the grayish color of many animals, particularly when the melanophores are contracted.

DENTITION.—The dentition (Fig. 3) appears to be characteristic of that described for the genus *Lampetra* by Regan (1911), Creaser and Hubbs (1922) and Berg (1931).

Just within the oral fimbriae there is a single circular series of small, blunt teeth (arciform in cross-section) which vary from 63 to 67 in number and average about 65. These frame the oral cavity and may be termed the border teeth; ventromesially they become smaller.

Immediately above the entrance to the throat is the supraoral lamina, which in the recently metamorphosed adult consists of two stout, obtusely pointed cusps whose points are directed centrally and downward. These are connected by a bridge which may be partly covered by the buccal epithelium. These cusps are somewhat variable in shape; in one animal one cusp had been developed centrad so that, instead of terminating in a blunt point, the anterior edge was chisel-like. They are usually light buff in newly metamorphosed animals, but darker tones have been observed in older animals.

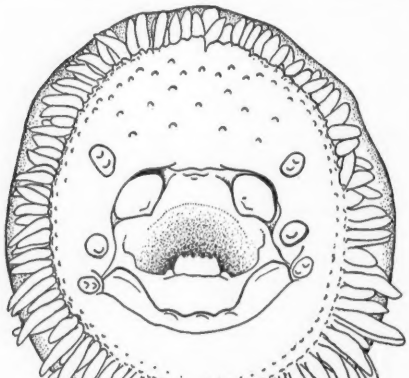


Fig. 3. Oral disk of brook lamprey, Bear Branch, Maryland. Magnified about 13 times.

The infraoral lamina, which is located on the posterior internal border of the buccal funnel (opposite the supraoral lamina), is broader than its upper counterpart. It is band-like, the longer axis of the lamina lying in the horizontal plane. The outer edge of the lamina is quite variable in design, but it is usually divided into five or seven very blunt "humps," which may be designated for convenience as reduced cusps. The two distad cusps on each side appear to be fused when only five may be counted; those outside cusps are then usually very large. Infrequently the infraroral lamina is band-like.

Laterally disposed at each side of the disk are three single or double cusps, arrayed in parallel with the lateral curvature of the buccal border. They lie near the throat, and are larger than those in the rest of the buccal disk, excluding the laminae. Each tooth of these sets has at least one cusp; some individuals have the anteriormost and posteriormost teeth bluntly bicuspid. The number of cusps appears to be variable.

On the anterior face of the buccal disk, between the supraoral lamina and the anterodorsal border teeth, there are three rows of teeth, all unicuspid, which exhibit a fairly constant morphological arrangement. From outside towards the pharynx, the number of teeth in each row is two, five and four.

No teeth were found on the posterior face of the buccal cone between the infraoral lamina and the border teeth. This observation is based upon macroscopic examination of more than two dozen adults of both sexes, and upon microscopic examination (970 ×) of complete serial longitudinal and cross-sections of this part of the adult animal, cut at 8 μ.

Other criteria.—In the original description of *L. aepyptera* by Abbott (1860) no reference is made to certain morphological characteristics found in Maryland populations generally referred to this species. It is beyond the scope of this paper to enter into a critical taxonomic discussion, but certain of these differences should concern the interested taxonomist and for that reason they are mentioned here.

The holotype is somewhat larger than the average length of the Maryland representative. It was reported in 1860 to be five and one-half inches long, which is probably very close to its original length. Fowler (1907) reported the type to be four and seven-eighths inches long (123.8 mm.); therefore it had undergone considerable contraction. Mr. Fowler did not collect new material from the vicinity of Portsmouth, Ohio, at this time. Only 12 percent of the Maryland lampreys measured by me have exceeded 123.8 mm., and none has been found to be 140 mm. long. Whether this is a genetic difference, a reasonable ecological

variation, or an actual species or subspecies difference remains to be determined.

Part of Abbott's description of the holotype does not appear to be correct, as the specimen itself will show. My observation (1952) was that the caudal fin is not higher than either dorsal fin; it is lower than both. From its present condition it is not readily possible to determine the relative height of the posterior dorsal fin of this ancient specimen; but a very serious doubt may be cast upon the accuracy of Abbott's statement that the anterior dorsal fin is the higher one of the two. However, the specimen is in bad condition, and the dorsal fins are badly frayed. In any case, the second (posterior) dorsal fin is higher than the first (anterior) in all adult specimens of the lamprey that I have caught. It is certain, then, that this part of Abbott's description cannot be used safely to define the fins of *L. aepyptera*.

The nomenclature of the non-parasitic brook lampreys of eastern North America has been discussed by Hubbs and Trautman (1937: 22–24) and also by Creaser (1939). There is no question that *Entosphenus appendix* (= *E. lamottenii* or *L. lamottei*) and *Lampetra aepyptera* are fully distinct species (see Vladykov, 1950). However, the figure of *aepyptera* in Creaser and Hubbs (1922: pl. 1) does not portray correctly the dentition or facies of this lamprey as represented in Maryland.

Therefore, with all of the foregoing in mind, I think that only a provisional classification of the Maryland representative as *L. aepyptera* seems practicable at this time.

Life History

The adult lamprey spawns in Crow and Bear Branches from about April 10 to May 10, possibly earlier. Adults can be found for several days afterward, but they became progressively moribund and soon die. They are similar to other non-parasitic lampreys in that the intestinal tract degenerates at maturity to a threadlike, useless strand.

In my experience, the females caught (usually between 1:00 and 5:00 PM) seem to complete their metamorphosis before the males. About three females to every two males are caught, and in the latter part of March and the first week in April the ratio is even greater: 3 to 1. Only in May are the males taken more frequently.

The water in the brook may be as cold as 11°C when the adults start to come forth from the brook bottom, but spawning does not take place until the temperature has risen to approximately 16°C. The lamprey selects a very shallow place where the water runs more slowly, and is found in naturally occurring ripple-like depressions in fine, graded gravel of the brook bottom, a little distance above riffles. This lamprey has been seen to transport stones, but its attempts at nest building are relatively uncoordinated. I have examined two nests, both hollowed out adjacent to a somewhat large stone (the latter perhaps two inches in diameter). No array of pebbles suggestive of artificial arrangement has been found; and spawning activities in laboratory aquaria under fairly close observation exhibit only sporadic attempts at picking up sand.

The nesting lamprey attaches itself by its mouth to a large pebble on the site selected, and with rapid vibratory motions of the posterior half of the body "fans" the fine gravel from underneath its body, creating an oval, bowl-shaped depression. The pairing lampreys both join in this activity. Such nests are not very deep, perhaps to three inches below the plane of the brook bottom; they are about seven or more inches in the longer diameter.

This activity merges into the spawning behavior. During nesting activity the labia of the female anus becomes bloodshot, and the fins of both lampreys may become flecked from small hemorrhages. In preliminaries to the sexual act, there has been observed a sort of sexual play as exhibited by the animals maintained in laboratory aquaria. This consists of a characteristic, slowly undulate swimming; the ventral side of the trunk rubs against the gravel, while the two animals interweave in and out. Eventually the male attaches dorsally to the head of the female (or to the stone or aquarium wall to which the female has already attached). In a sudden motion he curves the posterior part of his body sharply in a complete circle about the female, and brings the penile papilla into apposition with the reproductive aperture of the female. Anteriorly his body is arched tautly over the female, and that part of his body which encircles the female vent contracts convulsively at least once, perhaps a number of times. At the same time there is a rapid and violent vibration of the body of

both animals, particularly in the caudal region. The act is periodic and lasts for about three to five seconds at a time, with resting periods of variable extent in between. During this act the female extrudes one or more individual batches of two to four eggs, rarely more and usually three. At the time the female lays the eggs the male fertilizes them. The spawning movements are so fast that it is not possible to determine whether or not a form of intromission is achieved. Spawning in the laboratory usually

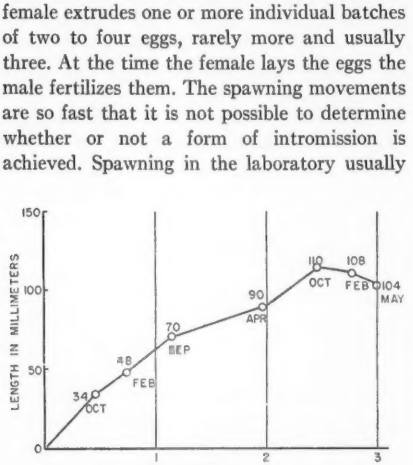


Fig. 4. Indicated changes in average length of *L. aepyptera* during development.

Dates are selected mainly on basis of being near beginning and towards close of the winter season, and are also when a considerable number of animals were taken. Of all larvae caught, 328 were measured during the period; 82 are considered first-year, 102 second-year and 144 third-year ammocoetes. The last includes metamorphosing animals.

occurs in subdued light or at night. A gravid female contains over 1,100 eggs (1,164 in one female by actual count), and practically all of them are laid.

Upon fertilization the jelly about each egg expands. The egg falls to the bottom where it is soon covered by fine particles of gravel which adhere strongly to the extremely viscid outer jelly. The flurry of gravel caused by the spawning motions of the parents, as well as the movement of gravel caused by the changing flux of the stream, may cover the eggs and protect them.

In aquaria it took about 265 hours for the 4-mm., cream-colored larvae to emerge from the eggs (temperatures ranged from about 18° to 22°C.). In the brook they are either then caught in the changing water currents or swim to fine silt beds in very quiet (but not stagnant) water, and which are dark from the presence of thoroughly decomposed leaves and other organic matter. In this locale the developing ammocoete appears to stay throughout its first year. By October 15 of this year it has achieved an average length of 34 mm., and no animal of this generation was dug up at the time that measured less than 28 mm. Animals up to a length of 43 mm. (at least) appear to be first year larvae, as based on a group of fifteen animals collected on October 15.

The progressive growth of the larvae and adults is illustrated in Fig. 4. The indicated life span is three years. An extensive sampling made on February 2 uncovered no larva shorter than 33 mm. in length, which is almost the average for the previous October 1–28 sample. It is safe to conclude, therefore, that these smallest of the February larvae constitute young-of-the year. In the interval of approximately 168 days since fertilization, the growth of 34 mm. in length represents an average of 1 mm. every five days. (It is recognized that this is probably not a straight line trend.) If this indicated growth were continued throughout the winter months, on February 2 (140 days later) the average length of this year-class would be 62 mm.

The 67 lampreys collected on February 2 fall into two size groups (clusters), separated by a gap roughly in the 67- to 77-mm. interval. In the first cluster the animals range in length from 33 to 66 mm. (There was one larva of 71 mm. length of doubtful category, which has been excluded from computation.) The wider dispersion of lengths may be expected as indicated by the development of the "spread" found in the previous October. The weighted average of this distribution is 48 mm., which shows that there is a definite slowing down of the rate of growth in colder weather.

This retardation of growth rate seems to be maintained until well along in the year. In the middle of August, however, the average length of 12 second-year larvae was 64.4 mm. By the last of September, 18 animals considered to be referable to this group had increased in mean length to 69.7 mm. It is this group, with a range in length from about 57 to 84 mm., which in turn forms a part of the second cluster of February 2.

This second cluster is believed to consist of two converging groups of animals: (1) those that are about to metamorphose (to spawn in April and May), and (2) those which will form the late larvae of the third year. This distinction is well supported: in May, June

and July, long after the adults of April and May have spawned and died, these larvae of practically adult body length can be dug out of the fine gravel bottom. Of the forty lampreys in the February 2 group, four were obviously metamorphosing. Because of limitations of time it has not been possible to autopsy each animal to determine the condition of its reproductive tract; however, sufficient examinations have been made to establish that there are two stages of development: one where the reproductive strand is a fine, relatively undeveloped cord of cells, and the other where the gonads have undergone most of the maturation process. The mean length of all apparently non-metamorphosing lampreys of this date is 97.5 mm., although this group without doubt includes animals which would have transformed shortly, as explained further below. Based on the preceding year's trends, the computed value would be about 87 mm. for non-transforming larvae.

The changes in length of metamorphosing near-adults and the lengths of adults are discussed earlier (and see Table I). For non-metamorphosing larvae, the weighted average length of twelve larvae on March 20 (the close of their second year) was 90 mm., which is almost precisely the indicated trend. Since transforming animals become adults in April and May, all remaining larvae of approximately these lengths represent third-year ammocoetes, which become adults in the fourth April or May of their existence, at the end of their third year. In early October these third-yearlings are, on the average, about 110 mm. long, practically the length of metamorphosing animals in their final spring months.

During their development the ammocoetes are found in different environments. The fine, mud-like silt of early larval life is exchanged in the second year for fine, sandy drifts, particularly under the lee of banks where the conformation of the brook protects the sand from the thrust of water flow. In the third year they are found in somewhat coarser sand, but they are dug up still much more frequently near the banks of the stream. In late winter and early spring these second- and third-year larvae may be found in numbers between layers of fallen leaves of the previous fall, particularly where the stream has piled sand over them.

The metamorphosing larva of February and March often buries its body up to its posteriormost gill-opening in the brook bottom, but leaves its head clear in the water. Such animals orient themselves facing stream flow and may be found anywhere in the fine gravel stratum of the brook bottom. Here they stay, presumably, until the urge to mate sends them to their nesting grounds.

The brook lamprey in Maryland evidently does not have to leave its brook during its lifetime. All stages have been found in a mile-long stretch of the brook. It is true, however, that as the larvae grow older they inhabit parts of Bear Branch progressively nearer Laurel Lake, and they may occur in the lake.

I wish to acknowledge with gratitude the encouragement, help and advice of the following: Drs. Sumner O. Burhoe and Robert A. Littleford of the Department of Zoology of the University of Maryland; Dr. Leonard P. Schultz, Curator of Fishes in the U. S. National Museum; Mr. Henry W. Fowler, Curator of Fishes in the Academy of Natural Sciences of Philadelphia; and Mr. William H. Bayliff, Executive Secretary of the Board of Natural Resources of the State of Maryalnd. Appreciation is expressed to Dr. Robert R. Miller of the University of Michigan for suggestions in the preparation of the manuscript and for taxonomic and bibliographic information. The research was aided by a pre-doctoral fellowship grant from the National Institutes of Health of the U. S. Public Health Service.

Literature Cited

Abbott, C. C. 1860. Description of new species of American fresh-water fishes. No. 5. *Ammocoetes aepyptera* Abbott. *Proc. Acad. Nat. Sci. Phila., 12: 327–28.*

Bayliff, W. H. 1942. [On Lampetra aepyptera in Maryland]. *Ann. Rept., Board of Nat. Resources, Dept. of Res. and Educ., State of Maryland, Publ. 47: 28–29.*

Berg, L. S. 1931. A Review of the lampreys of the Northern Hemisphere. *Trud: Biologicheskoi Assotsiatsii Akademii Nauk, USSR, 32, 87–116.*

Cook, Fannye A. 1952. Occurrence of the lamprey *Lampetra aepyptera* in the Tombigbee and Pascagoula drainages, Mississippi. Copeia *(4): 268.*

Creaser, C. W. 1939. A lamprey of the genus *Lampetra* from Indiana. Copeia *(3): 169.*

Creaser, C. W., and Carl L. Hubbs. 1922. A Revision of the Holarctic lampreys. *Occ. Pap. Mus. Zool. Univ. Mich., No. 120: 1–14.*

Fowler, H. W. 1907. Notes on lancelets and lampreys. *Proc. Acad. Nat. Sci. Phila., 59: 461–66.*

Hubbs, Carl L., and M. B. Trautman. 1937. A Revision of the Lamprey Genus *Ichthyomyzon.*

Misc. Publ. Mus. Zool. Univ. Mich., No. 35: 7–109.

MANSUETI, R. 1951. Occurrence and habitat of the darter *Hololepis fusiformis erochrous* in Maryland. COPEIA (*4*)*: 301–02.*

RANEY, E. C. 1941. Records of the brook lamprey, *Lampetra aepyptera* (Abbott), from the Atlantic drainage of North Carolina and Virginia. *Jour. Elisha Mitchell Soc., 57: 318–20.*

——— 1952. A new lamprey, *Ichthyomyzon hubbsi*, from the upper Tennessee River system. COPEIA (*2*)*: 93–99.*

REGAN, C. T. 1911. A synopsis of the Marsipobranchs of the Order Hyperoartii. *Ann. and Mag. Nat. Hist., ser. 8, vol. 7: 193–204.*

VLADYKOV, V. D. 1950. Larvae of Eastern American lampreys (Petromyzonidae). I.—Species with two dorsal fins. *Nat. Canadien, 77* (*3-4*)*: 73–94.*

9500 PAGE AVENUE, BETHESDA, MARYLAND.

Analysis of Growth in the Central Mudminnow, *Umbra limi*

PAUL S. STOKELY AND CLARENCE F. DINEEN

HECHT (1916) claimed that growth in teleost fishes was isometric, i.e., "the rates of growth for the different parts of the fish are identical." Hecht correlated with this isometry a constancy of external form which was established early in post-embryonic life and, except for some adaptive variations, changed little thereafter. He further suggested that such isometry and correlated constancy of form were associated with the supposed indeterminate growth of fishes as contrasted with the constantly changing form during the growth of animals with determinate growth such as mammals. However, there is some evidence that growth in fishes is not indeterminate. The data of Gerking (1952) indicate that the utilization of protein for growth by the green and longear sunfishes decreased with age as might be expected among animals with determinate growth. Moreover the work of Keys (1928), Hammett and Hammett (1939) and Morrow (1952) showed that the form of some fishes does change as a consequence of relative growth. But according to Hammett and Hammett (1939) growth in the gar (*Lepisosteus platyrhynchus* De Kay) is an essential straight-line relation of each part with that of the whole. In other words, growth can be expressed by the equation $Y = a + bX$ rather than the so-called logarithmic growth equation of Huxley (1932), $Y = bX^k$. In these equations Y represents a dimension of one part; X represents a dimension of the whole or of another part; "a" represents a basic size difference between X and Y unaffected by growth, what Huxley calls the "time-handicap given some organs as against others" or the value of Y when $X = 0$; the "b" is mathematically the slope of the line of regression of Y on X equal to the value of Y when X is unity; and the exponent "k" expresses the ratio of the geometric growth rates of Y to X and was termed by Huxley and Teissier (1930) the equilibrium constant. Hammett and Hammett (1939) concluded that, because they were able to detect changing proportions between parts during the growth of the gar by the use of the formula $Y = a + bX$, growth was not always "logarithmic." However, the work of Huxley (1932) and Simpson and Roe (1939) has shown convincingly that increase of size of living material is multiplicative—progressing at a geometric rather than an arithmetic rate—and that it can be most adequately expressed only by the logarithmic equation.

The relative growth between two parts growing at geometric rates can be expressed by either the equation $Y = a + bX$ or $Y = bX^k$, depending upon the circumstances. In some cases the change in relative proportion during growth results from "a," an initial non-growing difference between Y and X, and the formula $Y = a + bX$ is to be preferred. In most cases, however, "a" appears to be negligible (Simpson and Roe, 1939) and the change in proportions between two growing parts results from the fact that one part is growing at a faster or slower geometric rate than the other. This is the situation described as allometry where, in the equation $Y = bX^k$, k is greater or less

than 1. Since it was desired to detect allometric growth, however slight, the latter formula was used in the analysis of growth of the mudminnow.

The data used in the present study were obtained from measurements of 93 specimens of the central mudminnow, *Umbra limi* (Kirtland), collected from Judy Creek, just north of the campus of the University of Notre Dame, during the spring and summer of 1952. Measurements were taken with a pair of needle-pointed dividers and recorded to the nearest half-millimeter. The specimens ranged in standard length from 29 to 114 mm., from small postlarvae to adults. As a result of preservation in 5 percent untreated formalin for two to three months, some shrinkage undoubtedly occurred before measurements were made. However, it was felt that this was not of sufficient magnitude to invalidate the results. The measurements included standard length, lengths of head, pectoral and pelvic fins, and the length and depth of the caudal peduncle. These body dimensions were taken as defined by Hubbs and Lagler (1947). Although highly desirable, the tools used made it practically impossible to obtain with any degree of accuracy from the smaller specimens such dimensions as the orbital width or the lengths of the upper jaw, snout and orbit.

If the recorded measurements are converted into logarithms, the formula $Y = bX^k$ becomes $\log Y = \log b + k \log X$, and k is found as the coefficient of the regression of $\log Y$ on $\log X$ by the method of "least squares" according to the formula $k = \dfrac{\Sigma\, dX\, dY}{\Sigma\, d^2X}$. The values of k for the six different dimensions measured are given in Table I. The standard error (σk) of each equilibrium constant was found by the formula $\sigma k = S_y \sqrt{\dfrac{1}{\Sigma\, d^2X}}$ where S_y is the standard error of the estimate ($S_y = \sqrt{\dfrac{\Sigma\,[(y - yc)^2]}{N - 2}}$ Simpson and Roe, 1939). The values obtained by dividing the deviations of "k" from 1 by their respective standard errors were transferred to "p" values (Table I).

An inspection of the table shows that in no case is the deviation from 1 (isometry) very great. The greatest is that of the length of the pectoral fin with an equilibrium constant of 1.3046. The "p" value, however, is <0.006 which, statistically speaking, is very significant. The same is true for the slight negative allometry indicated by the "k" value of the head length, 0.9159. The degree of respective positive and negative allometry shown here is so slight that it undoubtedly has little effect on the form of a fish so small as the mudminnow. However, as Huxley (1943) pointed out, even a very slight allometry might have a pronounced effect upon the final form of an animal if it operates over a considerable range of absolute size. It must be remembered too, that all degrees of allometry within zoological limits can occur and that even a very slight degree of allometry can be highly significant statistically. It is more logical to suspect that, in cases where the deviation from 1 is slight, the difference is one of chance and not a real difference. But in the results reported here the sample was large and the "p" value so low,

TABLE I

MEASUREMENTS OF 93 SPECIMENS OF *Umbra limi*, WITH STATISTICAL DATA

Measurement	Range (mm.)	Median (mm.)	Median (log.)	k	S_y	σk	p
Standard length (X)	29–114	54.94	1.7399	....	....	....	....
Head length (Y_1)	9–33	16.35	1.2135	0.9159	0.0259	0.0209	<0.006
Body depth (Y_2)	6.5–24	12.35	1.0916	0.8946	0.0404	0.0327	<0.30
Length of pectoral fin (Y_3)	2–18	8.00	0.9031	1.3046	0.0675	0.0546	<0.006
Length of pelvic fin (Y_4)	4–16	7.98	0.9020	1.0504	0.0444	0.0359	>13.0
Length of caudal peduncle (Y_5)	6–21	10.97	1.0402	0.9154	0.0296	0.0240	<0.04
Depth of caudal peduncle (Y_6)	4–16	7.81	0.8927	0.9809	0.0398	0.0322	>55.0

that it seems certain that the growth in these two instances is truly allometric though very slight.

Since only "p" values <0.02 admit real significance, then the equilibrium values for the other dimensions given in the table are not indicative of allometry. The length of the caudal peduncle with a "p" value <0.04 but >0.02 is probably a border-line case. The greatest negative deviation of the "k" value from 1 is in the body depth (0.8946), but the "p" value is <0.30 and >0.02, therefore, the "k" value is of no significance. The "p" values for the length of the pelvic fin and the depth of the caudal peduncle are so high that no doubt arises as to their statistical insignificance.

The closest freshwater relatives of the Umbridae are generally recognized to be the Esocidae. It is striking that these are for the most part large fish as compared with the mud-minnows. A study of the growth of these larger fish as compared with the results herein reported might lead to some idea of the mechanisms underlying the evolution and divergence of these groups.

Literature Cited

Gerking, Shelby D. 1952. The protein metabolism of sunfishes of different ages. *Physiol. Zool., 25 (4): 358–72, 3 figs.*

Hammett, F. S., and D. W. Hammett. 1939. Proportional length-growth of garfish (*Lepisosteus*). *Growth, 3: 197–209.*

Hecht, Selig. 1916. Form and growth in fishes. *Jour. Morphol., 27: 379–400, 11 figs.*

Hubbs, Carl L., and Karl F. Lagler. 1947. Fishes of the Great Lakes region. *Cranbrook Inst. Sci., Bull. 26: i-xi + 186 pp., 251 figs., 26 col. pls., 1 map.*

Huxley, Julian. 1932. Problems of relative growth. *The Dial Press, New York: xix + 276 pp., 104 figs.*

——— 1943. Evolution the modern synthesis. *Harper and Bros., New York: 645 pp.*

———, and Georges Teissier. 1936. Terminology of relative growth. *Nature, 137: 780.*

Keys, Ancel B. 1928. The weight-length relation in fishes. *Proc. Nat. Acad. Sci., 14: 922–25.*

Morrow, James E., Jr. 1952. Allometric growth in the striped marlin, *Makaira mitsukurii*, from New Zealand. *Pacific Sci., 6 (1): 53–58.*

Simpson, George G., and Anne Roe. 1939. Quantitative zoology. *McGraw-Hill Book Co., Inc., New York: xvii + 414 pp., 52 figs.*

Department of Biology, The University of Notre Dame, Notre Dame, Indiana.

Color Perception in Trout

H. Wolf and J. H. Wales

STUDENTS of fish behavior and physiology have long debated the question, "Are fish color-blind?" This point is of particular interest to trout fishermen, who seem to be about equally divided, one school believing that trout can distinguish colors, the other that shade and pattern are distinguished, but not color.

Ichthyologists, in general, agree with the following statement of Carl and Clemens (1948), "Experiments have also proved that some fishes can distinguish certain colours, and that all fishes therefore are not completely colour-blind, as some persons believe." The *degree* of color sensitivity is the principal point in question, and the present writers wish to describe certain pertinent tests.

During the summer of 1952 it was suggested that the dry-meal pellets being fed to trout in the hatcheries of the California Department of Fish and Game might be eaten more readily if they were colored. Mr. Lee Talbott of this Department demonstrated that rainbow trout in hatchery ponds ate pellets colored red more quickly than the brown, uncolored ones. This led to further tests which proved beyond a doubt that rainbow trout in hatchery ponds not only preferred red pellets to uncolored ones, but preferred them to blue, yellow, or green ones.

The writers then decided to use brightly colored corks to investigate this point further. Number 4 and number 10 corks were colored red, green, blue, yellow, orange, brown, black, and white. They were presented to rainbow trout (*Salmo gairdneri*) and eastern brook

trout (*Salvelinus fontinalis*) in hatchery ponds in a variety of ways. All groups of fish, regardless of size and age, showed a marked preference for the red corks. The only other color which attracted them was orange, made by adding a few drops of red paint to yellow, but this was far less attractive than the pure red. The shade of red used is close to crimson as given in "Nomenclature of Colors for Naturalists" by Robert Ridgway (1886), but is the writers' belief that most, if not all, "reds" would have caused similar responses. When green, blue, yellow, brown, black, or white corks were tossed onto the surface of the ponds, the trout demonstrated a nearly uniform lack of interest. On the other hand, when a red cork was thrown among those of other colors, the fish literally "boiled" around it, striking it so vigorously that it would be knocked out of the water and soon driven to shore. The difference in the interest shown was so marked that this demonstration became a favorite pastime at the Mt. Shasta trout hatchery.

To obviate the possibility that taste or odor could be playing a part, variously colored corks were hung two to five inches above the water from strings stretched across the ponds. The trout would quickly congregate beneath the red corks and leap vigorously at them, completely ignoring all the other colors except the orange, which received minor attention. Brightness alone was probably not an important factor since both yellow and white were far "brighter" to the human eye than the red, and these were ignored along with the darker (blue, green, and black) corks.

Many students of color perception have questioned the ability of fish to distinguish between color and brightness. It is frequently asserted that fish are attracted by the brightness of an object more than by its color. In the tests made with colored corks, equipment was not available for measuring the brightness of the colors, but there seems little doubt that the yellow and white corks reflected more light than the red. It is admitted that the fish may evaluate red objects in a different manner than do human beings.

The trout-food pellets, colored by a red food dye, were not bright; instead, they were a dull "wine color," close to K2 (Plate 53) of "Dictionary of Color" by Maerz and Paul (1930). When some of these were placed on the pond bottom near a similar lot of uncolored, brown pellets the trout would pick up the red ones first.

The authors also tested the fish on bright red and "pale" salmon eggs and found that the red eggs were definitely preferred to the pale ones. This preference persisted for at least two months after yearling rainbow had been liberated in a mountain lake.

These tests indicate that trout can distinguish red under water as well as on the surface and in the air.

It was also discovered that the fish were much more positive in their reaction to the colored corks on bright, sunny days. The writers believe that light intensity, rather than water temperature, played a part in this, for it was quite obvious that the fish struck the "sunny side" of the red corks, driving them away from the sun. This was especially evident in early morning or late afternoon hours when the sun was low. At these times the red corks would be quickly driven to the shore away from the sun. Apparently the fish were unable to distinguish the red when looking into the sun, so they did not strike the cork from that side.

Rainbow trout of the same strain were tested with colored corks at other hatcheries and reacted even more positively than the fish at Mt. Shasta. Also, one of the writers tested colored pellets on a small group of wild brown trout (*Salmo trutta*) yearlings and found that they were attracted only to the red pellets.

It might be contended that the hatchery trout had become conditioned to red from a diet which tended to be reddish. Actually, most of the food in the hatchery diet is more brown than red, and when tested with a brown cork these fish showed no response. This point should be examined more thoroughly, but the writers doubt that this positive response to red was conditioned by the hatchery diet.

Various other species of fish have been tested for color perception by other workers. Curtis (1949) described tests made with certain aquarium fishes in which young jewelfish (*Hemichromis bimaculatus*) showed a definite, positive reaction to red, and young *Cichlasoma bimaculatum* reacted equally well to dark blue. In these tests, as in the ones which the writers made with trout, the factor of brightness has not been completely ruled out. In tests made

with young largemouth bass (*Micropterus salmoides*) by Brown (1937), the factor of brightness seems to have been ruled out and it could be said that this species definitely reacted in a positive manner to red, with yellow in second place.

Carl and Clemens (*op. cit.*) stated, "It is only when the fly or other lure is beneath the surface of the water that the colours become distinguishable to the fish." Similarly, Curtis (*op. cit.*), wrote, "It is probable that it is only when a lure is beneath the surface that its color can be told." These assumptions must be revised in the light of tests made with the colored corks suspended above the water surface.

LITERATURE CITED

BROWN, FRANK A., JR. 1937. Responses of the large-mouth black bass to colors. *State of Illinois, Div. Nat. Hist. Surv., 21 (2): 33–55.*

CARL, G. C., AND W. A. CLEMENS. 1948. The fresh-water fishes of British Columbia. *British Columbia Prov. Mus., Dept. Ed., Handbook No. 5: 1–132.*

CURTIS, BRIAN. 1949. The life story of the fish. *Harcourt Brace & Co., New York, 284 pp.*

MAERZ, A., AND M. REA PAUL. 1930. Dictionary of color. *McGraw-Hill Book Co., New York.*

RIDGWAY, ROBERT. 1886. Nomenclature of colors for naturalists. *Little, Brown and Co., Boston.*

CALIFORNIA DEPARTMENT OF FISH AND GAME, INLAND FISHERIES BRANCH, SACRAMENTO, CALIFORNIA.

Ichthyological Notes

FIRST RECORD OF THE RIBBONFISH, *TRACHIPTERUS TRACHYURUS*, FROM THE MAINLAND OF NORTH AMERICA.—Mr. L. L. Pelling of Williamsburg, Iowa, while vacationing at Fort Lauderdale, Florida, was attracted by a silvery flash in the surf near the Tenth Street causeway on January 18, 1952. On closer inspection he saw it was a strange-looking, ribbon-like fish over two feet long. As it feebly floundered in the shallow water, a wave nudged the odd creature close to shore and Mr. Pelling was able to capture it.

Realizing the unusual nature of his find and its possible interest to ichthyologists, Mr. Pelling took the fish to the University of Miami. Here Professor Luis R. Rivas recognized the scientific value of the specimen and arranged for its preservation and shipment to the United States National Museum.

This species may be distinguished from other members of the genus *Trachipterus* by the shorter, deeper body and the relatively low number of dorsal rays. The greatest depth of the Florida specimen (141 mm.) is contained about 5 times in the total length (estimated at 700 mm.). This proportion cannot be accurately determined, as the tip of the tail, an estimated 50 mm., is missing. The dorsal rays number 76 (probably a few missing). A review of the literature reveals that all other species of *Trachipterus* have a greater number of dorsal fin rays (more than 100) and are more elongate than the specimen herein figured (Pl. I).

Other counts taken from Mr. Pelling's fish are as follows: pectoral, 13; gillrakers, 3 + 10; tubes in lateral line, 112 (probably a few missing). Poey (1861, Memorias, 2: 420) gave for his Cuban species, *Trachipterus trachyurus:* dorsal rays, 82; pectoral, 15; pelvics, 6; and depth, 4 times in body length.

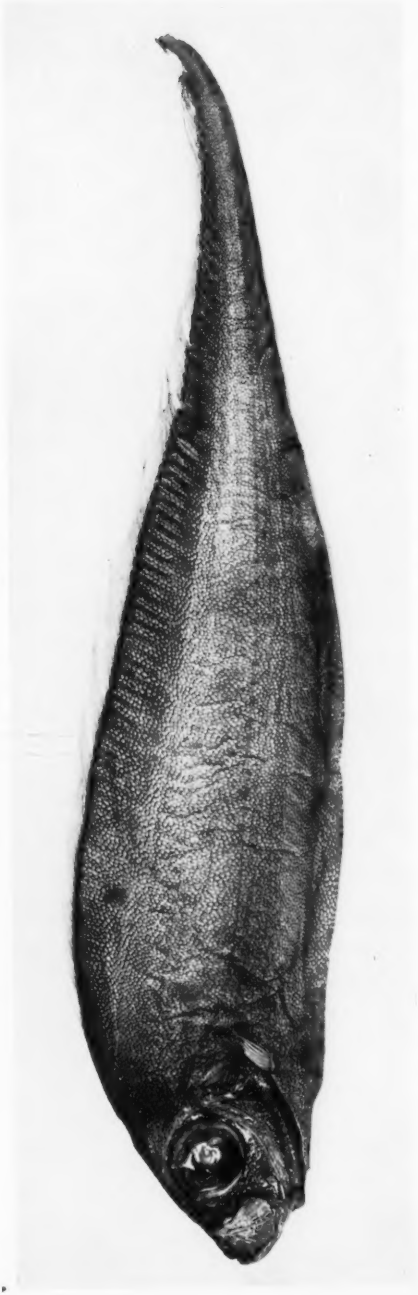
The color of the preserved specimen is as follows: body dusky to black with remnants of a silvery overcast; dorsal and pectoral fins transparent; head pale to black; iris black; mouth cavity black. In life the silvery coloration of the body was more predominant. The dorsal fin was described as crimson (Fort Lauderdale Daily News, January 24, 1952).

The anal fin is lacking in all members of this genus and the pelvic fins tend to decrease in size and may finally disappear with age. The Florida specimen lacks pelvic fins, but Poey's small specimen (112 mm.) had well developed pelvics.

In Poey's description of *T. trachyurus* he stated that in the area between the anus and the end of the tail, vertebral processes pierce the skin, showing their points externally. Apparently this condition is present only in the young, since no trace of it is evident in the larger Florida specimen.

On the basis of the foregoing comparisons I consider this to represent the second record of *Trachipterus trachyurus* Poey in the western Atlantic and the first record of the species for continental North America.—WILLIAM T. LEAPLEY, *Division of Fishes, United States National Museum, Washington 25, D. C.*

SECOND SPECIMEN OF THE EEL *GORGASIA PUNCTATA*, AN ADDITION TO THE KNOWN FISH FAUNA OF MEXICO.—The remarkable eel *Gorgasia punctata* was described by Meek and Hildebrand (1923, The Marine Fishes



Trachipterus trachyurus Poey
U.S.N.M. No. 165552, collected by L. L. Pelling at Fort Lauderdale, Florida, January 18, 1952.

of Panama, Pt. I: 133–34, Pl. VI) on the basis of a single specimen taken at Chame Point, on the Pacific side of Panamá. With hesitation, these authors referred this monotypic genus to the Derichthyidae; but in her classification of the eels, Trewavas (1932, Proc. Zool. Soc. London, Pt. 3: 639, 641–42, fig. 2) did not include it in that family. Fowler (1934, Proc. Acad. Nat. Sci. Phila., 85: 267–69, fig. 29) described *Benthenchelys* as a new genus from the Philippine Islands, and placed it in the same family. Neither *Gorgasia* nor *Benthenchelys* agrees with the diagnosis of the Derichthyidae as given by Trewavas, who regarded the group as monotypic. No attempt is made here to allocate either of these genera.

What appears to be the second known specimen of *Gorgasia punctata* has recently been received by the University of Michigan Museum of Zoology (No. 163007). It lacks from ⅓ to ½ of the posterior part of the body and is tightly curled, since it had been mutilated when caught. The head is 21.0 mm. long and, assuming that the ratio of head length to total length would be about the same as in the holotype (USNM No. 82222, 490 mm. long), I estimate that the total length of this Mexican specimen was 360 mm. The distance from snout tip to dorsal origin is 33.7 mm. and from snout tip to center of vent about 110 mm. The teeth are sharply pointed, canine-like on the vomer, and those at the front of the jaws are arranged in restricted, narrow bands that become uniserial, larger, and recurved at the sides; there is a single series of still larger, recurved teeth along the vomer. The anterior nostril is near the snout tip, has a moderate tube, and lies above the upper lip; the posterior nostril is an elongate slit near the front of the eye. The snout is very short and pointed, the eye large, lateral and grown over by skin. The mouth is small and oblique and the gape does not extend beyond the posterior margin of the pupil. The long dorsal fin originates just behind the tips of the small, but well developed, pectoral fins which have 11 or 12 rays (difficult to count). The pectorals lie behind and largely above the small gill openings, which are directed somewhat obliquely forward.

The new specimen was collected by Thomas MacDougall and sent to Dr. Hobart M. Smith, who kindly turned it over to the Museum of Zoology. It was picked up at the edge of the breakers just west of La Ventosa, on Bahía Ventosa, between Salina Truz and the mouth of the Río Tehuantepec, approximately 16° 12′, N. Lat., 95° 08′, W. Long., in Oaxaca, México, on January 20, 1950.

The data given above compare very favorably with those taken on the holotype of *G. punctata* which is in excellent condition. The two specimens agree in all technical characters, including details of pigmentation.

I am grateful to Dr. Leonard P. Schultz for permission to examine the holotype of *Gorgasia punctata* and for other kindnesses at the U. S. National Museum. He also compared the two eels and agrees that they represent the same species.—Robert Rush Miller, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

RECORDS OF THE BLACK RUFFE, *CENTROLOPHUS NIGER*, AND THE MACKEREL SCAD, *DECAPTERUS MACARELLUS*, IN THE GULF OF MAINE.—The otter trawler Aloha, while fishing for pollack, *Pollachius virens* (Linnaeus), near Mount Desert Rock, Maine, on October 12, 1951, caught a black ruffe, *Centrolophus niger* (Gmelin), in 75 to 85 fathoms of water. Maine Sea and Shore Fisheries warden Clayton Simmons brought the fish to us for identification. Since few specimens of this species have been taken in the Northwestern Atlantic (Bigelow and Schroeder, 1937, Copeia (1): 61), the following measurements (in mm.) of the Maine specimen are of interest: total length, 493; fork length, 454; standard length, 410; depth, 110; head, 82; eye, 16; maxillary, 29. The numbers of fin rays are: dorsal, 37; anal, 24; pectoral, 22; and ventral, 6. There are 205 scale rows. The color was bluish-black when fresh, but has faded to blackish-brown after storage in formalin for over a year. The fish, from which the viscera and gills had been removed, weighed 866 grams.

On September 20, 1951, a 79-mm. mackerel scad, *Decapterus marcarellus* (Cuvier and Valenciennes), was caught in a small school of comparable-sized alewives, *Pomolobus pseudoharengus* (Wilson), glut herring, *P. aestivalis* (Mitchill), and Atlantic herring, *Clupea harengus* Linnaeus, in Boothbay Harbor, Maine. The school was transported alive to the fisheries station and kept in an aquarium tank. The mackerel scad died in the tank several weeks later. This species is rarely taken in the Gulf of Maine (Bigelow and Schroeder, 1936, Bull. U. S. Bur. Fish., 48: 331) although it ranges northward to Nova Scotia.—Leslie W. Scattergood and Gareth C. Coffin, *U. S. Fish and Wildlife Service, Boothbay Harbor, Maine.*

OCCURRENCE OF THE CONGER EEL, *CONGER OCEANICUS* (MITCHILL), IN THE GULF OF MAINE.—So far as can be learned, no adult conger eel has ever been reported from the Gulf of Maine. According to Bigelow and Welsh (1925, Bull. U. S. Bur. Fish., 40 (1): 87), six larvae have been recorded from the Gulf, with an additional record from North Truro on Cape Cod (not stated whether larva or adult). A further record is given by Bigelow and Schroeder (1936, Bull. U. S. Bur. Fish., 48: 326) of two larvae which were picked up

on the beach at Newburyport, Massachusetts, in November, 1929.

On July 15, 1949, Mr. William C. Countryman of Norwich University handed me a living leptocephalus larva which had been picked up on the beach of Gerrish Island at the mouth of Portsmouth Harbor, New Hampshire. This larva was perfectly transparent except that the eyes were of a brillaint golden hue and very conspicuous even at some distance. The specimen was 96.5 mm. in length and 6.6 mm. in body width at the anterior margin of the dorsal fin. The head was 4.6 mm. long, and the oval eyeballs were 1.7 mm. on the longest axis. The upper jaw was slightly hooked and projected very little beyond the lower jaw. The head seemed very small in proportion to the width of the body. On hardening in alcohol, more details became apparent. There are 151 muscular segments (only 107 in the leptocephalus stage of the American eel), with 52 myomeres in front of the dorsal fin. There is a row of 85 minute black dots along either side of the body, with 101 similar dots along the ventral surface; these were not visible in the living specimen. Numerous small black pigment spots also occur at the base of the anal and dorsal fin rays. The leptocephalus stage of the conger eel is supposed to grow to a length of 150 to 160 mm. The present specimen seems reasonably far advanced, basing this judgment on the development of the finfolds and the pectoral fins which were well formed, although the total length of this larva was less than 100 mm. The specimen has been deposited in the collection of the University of New Hampshire.—C. F. Jackson, *University of New Hampshire, Durham, New Hampshire.*

ARCTIC OR POLAR COD, *BOREOGADUS SAIDA*, IN MIRAMICHI BAY, NEW BRUNSWICK.—*Boreogadus saida* (Lepechin) is known to be circumpolar, and is abundant in the Arctic seas of Asia and North America where it is commonly found in Hudson Bay and about Greenland. However, there are few records of its occurrence south of Greenland along the east coast of America.

Since it is small and not sought for food in the same way as trout and cod (*G. callarias*), it has no doubt often been overlooked or mistaken for the young of its larger cousin during the years of fisheries investigations in the Gulf of St. Lawrence and about Newfoundland. Suitably cold Arctic water extends southward along Labrador, to Newfoundland, into the Gulf of St. Lawrence and even to eastern Nova Scotia, though in the more southerly regions this water occupies an intermediate depth with warmer water both above and below it in summer. In winter, however, the upper layer becomes cold and, at least from the temperature standpoint, any Arctic species living in this cold tongue of Arctic water could move inshore into shallow water in all of these regions.

In 1909, Kendall (The Fishes of Labrador, Proc. Portland Soc. Nat. Hist., 2 (8): 207–43) reported two specimens of *B. saida* from Chateau Bay, Belle Isle Strait (Lat. 52° N., Long. 55° 52′ W.), but Vladykov has thrown doubt on this record because of the extremely low number of gillrakers (24 compared to 36–42 according to Vladykov). In any case this questionable record stood as the most southerly capture of this species on the Atlantic coast of North America until Vladykov (1945, Naturaliste Canadien, Quebec, 72 (1–2): 27–39) recorded it along the north shore of the Gulf of St. Lawrence and in the St. Lawrence River.

TABLE I

MEASUREMENTS (IN CM.) AND OTHER DATA ON FOUR SPECIMENS OF *Boreogadus saida*

Character	1	2	3	4
Length:				
Total	21.6	21.3	25.0	19.3
Fork	20.8	20.3	23.7	...
Standard	19.6	19.1	22.5	...
Head	5.3	4.8	5.9	5.2
Snout	1.6	1.5	1.8	1.5
Barbel	.15	.10	.20	.20
Premaxillary	...	1.8	2.3	1.8
Pectoral	3.7	3.2	3.7	3.5
Caudal peduncle	...	2.5	2.4	2.3
Interorbital	1.3	1.1	1.4	1.2
Eye	1.1	1.1	1.2	1.1
Gillrakers (left side)	33 + 10	34 + 10	28 + 10	30 + 8
Fin rays:				
First dorsal	11	13	12	13
Second dorsal	13	13	14	16
Third dorsal	18	23	19	21
First anal	16	17	15	17
Second anal	21	21	19	19
Ventral	6	5	6	...
Pectoral	17	18	17	16
Vertebrae*	..	54	55	54
Sex	♂†	...	...	...

* Not including the urostyle.

† This specimen was in an advanced stage of sexual maturity, indicating it would spawn in the late winter or early spring, thus agreeing with Vladykov's findings.

In the trap-net fishery for smelt in the Miramichi estuary (Lat. 47° 10′ N., Long. 65° 05′ W., approximately) during late January and February, 1951, four specimens of Arctic cod (Table I) were obtained; these were caught in 1½-inch-mesh smelt nets set beneath ice up to 2½ feet in thickness and

in water temperatures of −1.5°C. According to reports no doubt others were taken, but were considered to be "just a queer sort of young cod fish with a forked tail and lower jaw stuck out beyond the upper." These reports also indicate that these fish had never been seen before by the fishermen who took them. It appears, thus, that conditions during the 1950–51 winter were such as to bring these fish into Miramichi Bay and that usually such conditions do not obtain. The 1950–51 winter in this area was remarkable for its relatively mild weather.

In all of the specimens the lower jaw protruded and the peritoneum was heavily speckled with black.

Our specimens were sent to the Royal Ontario Museum of Zoology, Toronto, where Dr. W. B. Scott, Curator, Division of Ichthyology and Herpetology, verified them; specimens 1 and 2 are now in that institution. Specimens 3 and 4 are in the collections of the Atlantic Biological Station, St. Andrews, N. B.—R. A. McKenzie, *Atlantic Biological Station, St. Andrews, New Brunswick.*

RECORDS OF UNCOMMON FISHES FROM PUGET SOUND.—During the summer of 1949 near the University of Washington Oceanographic Field Laboratory on San Juan Island, Puget Sound, 60 species of fish in 31 families were obtained. This report lists the more uncommon fishes collected.

Alepidosaurus aesculapius (Bean), handsaw fish. —One specimen was caught by a sports fisherman while trolling for salmon off Point Lawrence, Orcas Island. *Bothragonus swani* (Steindachner), deep-pitted sea poacher.—One specimen was taken from a tidepool one-half mile south of False Bay, San Juan Island. *Lyconectes aleutensis* (Gilbert), red devil.—Dredging in West Sound, Orcas Island, yielded one specimen. *Ptilichthys goodei* (Bean), quillfish.—Collecting at an underwater light at Friday Harbor produced six specimens. Two more were seen. Dr. Robert Fernald observed two during the summer of 1948. *Synchirus gilli* (Bean), manacled sculpin.—Two specimens were caught from the dock at the Oceanographic Laboratory and one was caught in a plankton tow through the kelp off Brown Island. *Trachipterus rexsalmonorum* king-of-the-salmon.—One specimen in very poor shape was brought to the Laboratory by reef-netters.—Earl T. Walker, *Department of Research and Education, Solomons, Maryland.*

A FALL RECORD OF THE SAND SHARK, *CARCHARIAS TAURUS*, IN NORTH CAROLINA.—According to Bigelow and Schroeder (1948, Fishes of the Western North Atlantic, Pt. I: 105–06) the sand shark, *Carcharias taurus* Rafinesque, is abundant along the east coast of the United States north of Delaware Bay during the summer, but it occurs frequently from Delaware Bay to Florida only during the warm months.

On the morning of November 23, 1952, a dead female sand shark measuring 245 cm. in total length was discovered at the high-water mark on the north beach of Bogue Sound, Carteret County, North Carolina, approximately 4½ miles west of Beaufort Inlet and directly in front of the University of North Carolina's Institute of Fisheries Research. This shark had been dead but a few hours, and no external or internal injuries were evident.

Smith (1907, North Carolina Geol. and Econ. Surv., 2: 37) reported that two large sand sharks had been taken at Beaufort, but it is not clear whether the specimens were actually collected in the sounds or in the ocean. Gudger (1913, Proc. Biol. Soc. Washington, 26: 98), unable to find sand sharks in the sounds, stated that such an occurrence was rare. Although the sand shark recorded herein was discovered well within Bogue Sound, there are two possibilities that it occurred there fortuitously. First, the dead, or dying, shark may have been swept into the sound from the ocean on the flood tide of the previous night; second, the shark may have been captured in the ocean by a local menhaden boat and thrown overboard as a trash fish when the boat was being unloaded at the processing factory (three such factories exist ¼ mile west of the spot where the shark was found). Inquiries concerning such disposal of the shark failed to give any confirming information. Although this specimen may not have occurred naturally within Bogue Sound, it represents the first recorded appearance of this species in North Carolina waters in a cold month.

The following proportional dimensions, in percentage of total length, are given for comparison with the smaller specimens listed in Bigelow and Schroeder (*op. cit.*: 101) and Radcliffe (1916, Bull. U. S. Bur. Fish., 34 (1914): 245): *Trunk at origin of pectoral:* breadth 11.0, height 11.6. *Snout length in front of:* outer nostrils 2.6, mouth 3.5. *Eye:* horizontal diameter 0.6. *Orbit:* horizontal diameter 0.8. *Mouth:* breadth 9.0. *Labial furrow length:* lower 2.0. *Nostrils:* distance between inner ends 3.1. *Gill opening lengths:* 1st 5.4, 2nd 5.8, 3rd 5.8, 4th 5.8, 5th 5.1. *First dorsal fin:* vertical height 5.7, length of base 7.5. *Second dorsal fin:* vertical height 5.6, length of base 6.6. *Anal fin:* vertical height 5.2, length of base 6.7. *Caudal fin:* upper margin 26.2, lower anterior margin 10.1. *Pectoral fin:* outer margin 13.9, inner margin 6.1, distal margin 9.8. *Distance from snout to:* 1st dorsal 38.4, 2nd dorsal 60.2, upper caudal 73.8, pectoral 20.0, pelvic 50.4, anal 64.7. *Interspace between:* 1st and 2nd dorsal 13.1, 2nd dorsal and caudal 7.0, anal and caudal 4.2. *Distance from origin to origin of:* pectoral and pelvic 22.0, pelvic and anal 14.6.

Oviducts and ovaries of each side were similar in size, the latter about as large as the fist of a man. A tube-like section of the oviduct approximately 2 cm. in outside diameter extended for about 50 cm. from the shell gland to a sac-like expansion. This expansion was approximately 5 cm. in outside diameter and extended to the cloaca. Dissection of the oviducts showed no embryos, egg capsules, or eggs, and an examination of the ovaries showed no ovarian eggs. In view of Springer's (1948, COPEIA, No. 3: 153–55) descriptions of the reproductive system of adult female sand sharks, it appears that the above specimen was immature.

Bigelow and Schroeder (*op. cit.*: 103) stated that *C. taurus* may attain maturity at a length of seven feet or upwards. In a 239-cm. female examined by Springer (*op. cit.*: 153), an embryo 83 cm. long was found; this female, though slightly smaller than the Bogue Sound specimen, was mature. The limited knowledge available concerning the size at maturity of female *C. taurus* indicates that considerable individual variation exists.—WILLIAM E. FAHY, *University of North Carolina, Institute of Fisheries Research, Morehead City, N. C.*

FIRST RECORD OF THE MARINE FISH *CENTROPOMUS UNDECIMALIS* IN SOUTH CAROLINA.—At Bears Bluff Laboratories on Wadmalaw Island, 25 miles southwest of Charleston, South Carolina, are two saltwater ponds, each of about an acre. These ponds connect with a tributary of the Wadmalaw River by a floodgate. A short distance from the Laboratories the Wadmalaw River flows into the North Edisto River which empties into the sea about 8 miles from the Laboratories.

One of the ponds was drained and new water allowed to enter on December 26, 1951. On September 30, 1952, the floodgates were again opened and the pond drained. Some 200 pounds of marketable fishes and 25 pounds of shrimp were taken from the pond.

Among the fishes was one specimen of a snook, *Centropomus undecimalis* (Bloch), 124 mm. in standard length. Snooks are not usually found north of Florida and there appears to be no previous record for South Carolina. Dr. Leonard P. Schultz, of the U. S. National Museum, wrote on October 22, 1952 that the northernmost specimen in that Museum is from Savannah, Georgia, taken in December, 1887.

Not only is it noteworthy that a young snook should be taken so far north of its usual range (West Indies, Texas to Florida), but it is interesting that it should be found in an impounded saltwater pond. It is likely that this individual entered the pond on December 26, 1951. It was possible for an extremely small fish to have passed through the floodgates on June 8, on July 6–7, and on August 4–6, when high spring tides forced the floodgates open slightly (one-half inch or less).

From December 26, 1951, to September 30, 1952, the maximum salinity of the pond was 30 ppt, the minimum, 14.4 ppt. The maximum temperature was 37°C, and the minimum was 8°C.

In the pond from which the snook was taken were such invertebrates as *Crassostrea virginica; Penaeus setiferus; Callinectes sapidus* and numerous xanthid crabs; and such fishes as *Mugil cephalus, Sciaenops ocellata, Leiostomus xanthurus, Cynoscion nebulosus, Bairdiella chrysura,* and *Pogonias cromis.*

The identity of the specimen was confirmed by Luis René Rivas of the Marine Laboratory, University of Miami, to whom thanks are expressed. The specimen is deposited with the Charleston Museum as No. 52.138.1.—G. ROBERT LUNZ, *Bears Bluff Laboratories, Wadmalaw Island, South Carolina.*

NOTES ON MULLET (*MUGIL*) SWIMMING UPSIDE DOWN.—While collecting snails near Miami Beach, Florida, between Fisher Island and Virginia Key, on September 16, 1952, Dr. W. H. Leigh, R. B. Holliman and I noticed many schools of mullet (*Mugil* sp.) coming in close to the sand flats where we were working. In one such school of about 15 fish we saw what we thought was an albino specimen. Further examination revealed that this particular fish was swimming on its back, its upturned belly giving the illusion of albinism. We could clearly see the dark back of the fish, and the ventral fins near the surface of the water. We had no seine with which to capture the fish, but attempted to surround the school and drive them on to the beach. In its efforts to avoid being captured the school swam swiftly around us, remaining tightly packed together all the time. During this period, not once did the upside-down mullet become separated from the rest of the school or in any way appear hampered by its unusual position. It possessed the same speed and agility as the rest of the school, and although we did not succeed in capturing the fish for closer study, there appeared to be no sign of injury or external malformation. It was thought that possibly during development either the semicircular canals or the air bladder had not properly formed.

On October 10, I was collecting with Mr. Nardo Zaias when we noticed another mullet swimming upside down. This was at the mouth of a small tidal estuary on Key Biscayne, an island about two miles south of the place where the first mullet had been seen. This fish was also in a large school, but when pursued it was not able to swim so fast as the other individuals. After about a five-minute chase the fish became exhausted and we were able to capture it. The specimen proved to be the striped mullet, *Mugil cephalus.* The fish was kept alive in

a freshwater aquarium for several hours. On first entering fresh water it seemed to be perfectly normal, except for a weakened condition, and maintained itself in the usual position of fishes. After about five minutes, however, the fish began to roll toward its left side and soon swam with about a forty degree list, continuing in this position for about twenty minutes. At this point we were forced to leave, and upon our return found the fish dead. Since the fish was transferred directly from salt to fresh water, its death may have been due to the drastic change of salinity.

Examination in the laboratory showed no sign of abnormality or injury. The air bladder seemed to be perfectly formed and in its usual place, ventral to the vertebral column. On dissection, the semicircular canals appeared to be normal, with no obvious injury or malformation.

It is possible that the two fishes observed on these different dates were the same individual, since the distance between the two localities is not great. We are able to offer no further explanation for this upside-down behavior except for the possibility of disease, which, in its early stages, would be manifest only as a weakening effect upon the fish. We were led to believe that, if this condition had existed for any great length of time, it is probable that the dark pigment of the back would have migrated to the belly, and since the coloration was normal, it was assumed that this behavior was newly acquired. Perhaps commercial fishermen commonly note this type of swimming, but we have observed many schools of mullet since that time and have not been able to locate another fish that was swimming upside down.—DONALD P. DE SYLVA, *Department of Zoology, University of Miami, Coral Gables (University Branch) 46, Florida.*

THE ORTHOPEDIC ARTHROMETER FOR THE PRECISE MEASUREMENT OF ANGLES IN SYSTEMATIC ICHTHYOLOGY.—The trend in modern taxonomic ichthyology is to describe the angles of a fish in a quantitative manner with the aid of a protractor-like device. Precise measurements are thus rapidly replacing ambiguous and meaningless terms which frequently result in confused diagnoses. Hubbs (1946, COPEIA, (2): 79–80) has described the construction of an arm protractor which was made from a large protractor and a strip of plexiglass. However, some workers may prefer a metal instrument which is a standard line of equipment with any of the larger surgical supply companies.

The Robinson pocket arthrometer is commonly used by orthopedic physicians for measuring the range of motion of the joints of the extremities. The protractor portion of the instrument is provided with a solid metal arm which extends 120 mm. from the side. Riveted to the mid-point of the base of the protractor is a metal indicator arm which can be rotated to measure any angle up to 180 degrees. Since the instrument is chrome plated, it is resistant to rust. The total length of the arthrometer is 170 mm., but metal extentions can be spot welded to the arms for measuring large fish specimens. The arthrometer comes conveniently equipped with a leatherette case and sells for about $4.50.—BRUCE W. HALSTEAD, *School of Tropical and Preventive Medicine, College of Medical Evangelists, Loma Linda, California.*

A LIGHTED BOX FOR TAGGING FISHES AT NIGHT[1].—Tagging is an important part of the study of the striped mullet, known locally as Florida black mullet (*Mugil cephalus* L.), which is being conducted by the Marine Laboratory of the University of Miami for the State Board of Conserva-

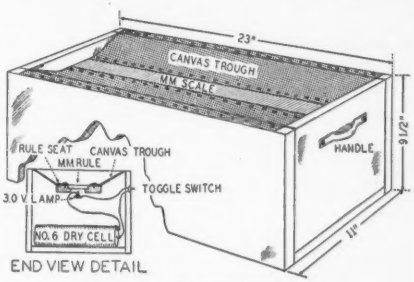


Fig. 1. Sketch of lighted tagging box.

tion. Fish to be tagged are obtained from fishermen during commercial operations, which are frequently carried on at night, so that much of the tagging must be done at that time. The fishermen use lights during removal of the entangled mullet from the net, but when this phase is complete, the lights are extinguished and subsequent tagging must be done in darkness. This makes it difficult to manipulate tagging pliers and to take accurate measurements of the fish. To permit night tagging, a lighted tagging box was designed (Fig. 1). The light in the box had to be dim, so as not to interfere with the search for fish.

The box in use is 23 inches long, 9½ inches high, and 11 inches wide, outside measurements. It is made of ⅜-inch planed yellow pine put together with screws and sealed with putty. The trough in which the fish are placed to obtain measurements is made by tacking heavy canvas from the two long edges of the box to two ¾-inch pieces of hardwood which are attached to the ends of the box. Between the two pieces of wood is set a millimeter rule con-

[1] Contribution No. 97 from the Marine Laboratory, University of Miami.

structed of heavy, clear lucite plastic with white translucent paint on the underside to diffuse the light. The face of the rule, with measurements marked in black, is 2½ inches below the top of the box. The numbered Petersen tag discs are placed on the tagging pins and arranged on the sides of the trough in numerical order by pushing the pins into the canvas. The trough serves to hamper the movements of the fish.

The light sources are four equally spaced 3.0-volt lamps which are connected in parallel to two Number 6 dry cells connected in series. An outside toggle switch at the upper left hand corner on the back side of the box opens and closes the circuit. The entire electric system is insulated by spraying it with varnish dissolved in xylene. The circuit is thus protected from seepage of water through the box and from condensed water vapor.—H. P. MEFFORD, *The Marine Laboratory, University of Miami, Coral Gables, Florida.*

CONSTANT TEMPERATURE BATH FOR EXPERIMENTAL AQUARIA IN LINEAR SERIES.—In experiments on the effects of temperature on the meristic characters of fishes, I have successfully used a simple bath for maintaining temperature equilibria in a linear series of aquaria (Fig. 1). The contrivance is applicable without basic modification to all set-ups where circulating water is not required within the individual tanks and where temperatures to be maintained are above that of the surrounding air.

The basic unit for the device is a wooden trough such as those used in trout and salmon hatcheries. This trough is lined with metal (light gauge galvanized iron is suitable) with a space approximating two inches between the liner on each side and the sides of the wooden trough (Fig. 1, lower right). A paddle wheel (Fig. 1, lower left), cut and formed from a single piece of 22-gauge galvanized iron, circulates the water in the space between liner and trough. The paddle wheel is driven continually at about twenty revolutions per minute through reducing gears by an electric motor. The circulating water passes from the immersion heater (Calrod) at one end to the thermostat (General Electric, good) at the other. Because the temperature-controlled water circulates about the water-filled inner trough, not through it, there is no linear temperature gradient in this inner area nor in the tanks placed in series within it.

Temperatures below those of the room may be obtained by running a small stream of water cooler than the air into the trough at the immersion heater and setting the thermostat to warm the mixture of inflow and moving stock to the desired level. If this is done, an overflow drain must be installed near the heating element of a size large enough to accomodate the effluent. Using such an arrangement, I was able to maintain temperatures for sixty-day periods at 60° ± 1°F and at 70° ± 1°F, as read on a Tycos pocket thermometer graduated in degrees F. Aeration of the tanks with compressed air through carborundum aquarium diffusers did not effect temperature differences in or between tanks.

A. D. Moore helped me design this apparatus.—KARL F. LAGLER, *Department of Fisheries, University of Michigan, Ann Arbor, Michigan.*

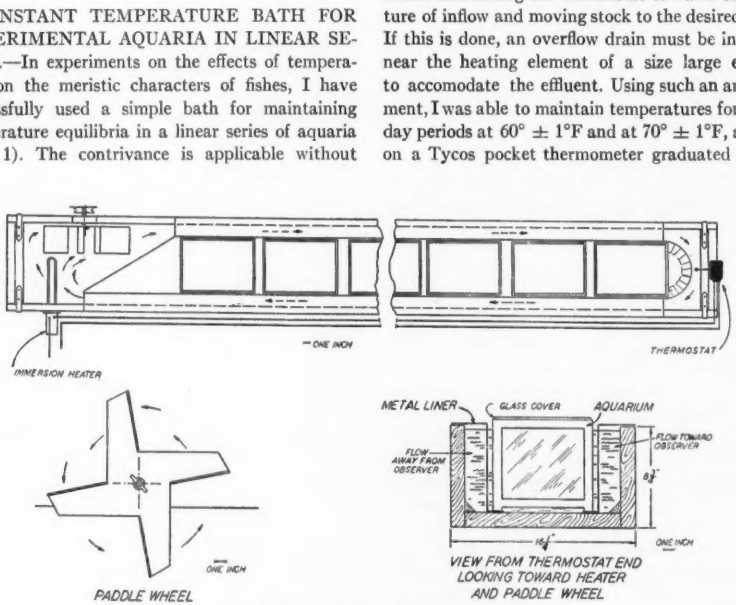


Fig. 1. Details of constant temperature bath.

Herpetological Notes

LONGEVITY OF SNAKES IN CAPTIVITY IN THE UNITED STATES AS OF JANUARY 1, 1953.—This list contains what records are available to us. We would like to hear from anyone having better records, or ten year records of other species. We intend to bring the list up to date each year as of the first of January. Only the oldest snake of each species or subspecies is listed. Age is given in years (second column) and months (third column), and the source of the record is included (fourth column). An asterisk indicates that the specimen was alive on January 1, 1953. Symbols used are as follows: AM = American Museum of Natural History, BdZ = Brookfield Zoo, BxZ = Bronx Zoo, GOW = Grace O. Wiley, GPM = George P. Meade, JGM = John G. Moore, NCM = North Carolina State Museum, PZ = Philadelphia Zoo, RMS = R. M. Stabler, SDZ = San Diego Zoo, SIZ = Staten Island Zoo, SLZ = St. Louis Zoo, TC= Tabor College, WZ = Washington Zoo.

*Agkistrodon contortrix laticinctus**	12	7	SDZ
*Agkistrodon contortrix mokeson**	16	6	SDZ
*Agkistrodon piscivorus**	17	8	RMS
Boa constrictor constrictor	12	3	PZ
Boa constrictor imperator	15	3	SDZ
Boiga dendrophila	11	9	SLZ
Corallus annulatus	12	4	PZ
*Corallus enydris cooki**	13	8	SDZ
Crotalus adamanteus	14	9	NCM
*Crotalus atrox**	16	7	SDZ
Crotalus basiliscus basiliscus	10	1	SDZ
*Crotalus cerastes laterorepens**	10	8	SDZ
*Crotalus durissus durissus**	11	0	SLZ
*Crotalus horridus horridus**	15	7	SDZ
Crotalus mitchelli pyrrhus	11	9	SDZ
Crotalus ruber ruber	12	3	SDZ
*Crotalus tortugensis**	15	9	SDZ
*Crotalus unicolor**	12	5	SDZ
*Crotalus viridis helleri**	15	10	SDZ
*Crotalus viridis viridis**	14	1	SDZ
Dendroaspis viridis	11	3	SLZ
*Drymarchon corais couperi**	20	4	JGM
Elaphe guttata guttata	21	9	PZ
*Elaphe obsoleta obsoleta**	15	6	AM
*Elaphe obsoleta quadrivittata**	15	7	SDZ
*Elaphe obsoleta spiloides**	11	5	RMS
*Epicrates angulifer**	14	2	SDZ
Epicrates cenchria crassus	14	6	SIZ
Epicrates cenchria maurus	27	4	BxZ
Epicrates striatus	16	0	PZ
Eunectes barbouri	13	11	PZ
Eunectes deschauenseei	13	10	PZ
Eunectes murina	28	0	WZ
Helicops schistosus	12	3	PZ
*Hemachatus haemachatus**	11	6	BdZ
*Lampropeltis doliata amaura**	16	7	GPM
*Lampropeltis doliata annulata**	12	5	SDZ
Lampropeltis getulus brooksi	10	0	SDZ
Lampropeltis getulus californiae	14	10	SDZ
*Lampropeltis sonata multicincta**	13	4	SDZ
Lichanura roseofusca roseofusca	12	0	SDZ
*Lozocemus bicolor**	10	0	PZ
Masticophis flagellum piceus (black)	11	2	SDZ
Masticophis flagellum piceus (red)	12	2	SDZ
Masticophis flagellum testaceus	13	5	SDZ
*Naja melanoleuca**	24	3	SDZ
Naja naja	12	4	PZ
Naja naja atra	10	3	BdZ
*Naja nigricollis**	18	2	BdZ
Naja nivea	15	3	SDZ
Ophiophagus hannah	11	10	GOW
*Pituophis catenifer affinis**	12	8	SDZ
Pituophis catenifer annectens	15	2	SDZ
Pituophis catenifer catenifer	11	0	SDZ
*Pituophis melanoleucus melanoleucus**	12	5	SDZ
Python curtus curtus	17	5	SLZ
*Python molurus bivittatus**	16	7	SDZ
Python molurus molurus	13	0	PZ
Python reticulatus	20	0	SLZ
*Python sebae**	16	1	PZ
*Rhinocheilus lecontei lecontei**	11	1	SDZ
Sistrurus catenatus	14	0	TC
Ungaliophis continentalis	17	8	GOW

—C. B. PERKINS, *Zoological Society of San Diego, San Diego, California.*

REVIEWS AND COMMENTS

NATURAL COMMUNITIES. By Lee R. Dice. University of Michigan Press, Ann Arbor, 1952: x + 547 pp., 52 figs., $5.50.—Ecologists have barely begun to learn the nature of the complex interrelationships that exist between living organisms. It is disturbing, therefore, to realize that the information already available is so voluminous that it is becoming virtually impossible to summarize it and difficult to interpret it in a single book. Dice, one of the few biologists in America with the necessary diversity of interests and background, has ably undertaken the task. He takes up community ecology, with the intention of defining and interpreting its more important methods and

concepts. "The division of ecology that treats of communities" as contrasted to the "individual ecology of single organisms," is, needless to say, a far more complex field of investigation, although as Dice notes, there is no clear cut distinction between the two fields.

In a brief review it is possible to do little more than convey the impression that this is an important book, not merely because it contains twenty-three chapters, a bibliography and an index. A fair amount of space is devoted to definitions, or to discussions of methods suitably employed to describe or measure communities, or to estimate populations. There are chapters dealing with the effects of fluctuations in physical conditions, with fluctuations in populations and with fluctuations in community composition. Home ranges and territories, ecological succession, and communities of the past, are admirably dealt with in separate sections, and there is a brief chapter on the evolution of communities. Mention of these few headings, however, provides little more than a rough approximation of the book's contents.

Like the authors of most text books of ecology, Dice has been hampered somewhat by the necessity for defining such terms as "niche" that have been widely used, but not always with the same meaning. Realizing the futility of trying to interpret or to describe communities with mathematical precision, Dice leans toward a broader definition of such terms.

Elton once commented that "ecology should not be made to appear more abstruse and difficult than it really is, and that it should not be possible to say that 'ecology consists in saying what everyone knows in language that nobody can understand.' " Dice, whose papers are never obscure, need not have been disturbed by this admonition. His book is written in a simple style that the average undergraduate can comprehend. To some ecologists portions of Dice's book may seem like the "painful elaboration of the obvious." It may be questioned whether it is necessary to depict a rabbit sitting under a blackberry bush in order to illustrate the minimum membership ("two associated individual organisms") in any community. However, students who have been forced to wade through texts overburdened with technical terms and obscure phraseology will not object to the simplicity of Dice's presentation.

Despite the fact that ecologists have learned a great deal, it sometimes seems that their vocabulary increases at a rate out of proportion to the rate of increase in knowledge. Many ecologists find it difficult to prepare even a small report without coining new terms, and it is virtually unheard of for one to write a book without attempting to augment the reader's vocabulary. Dice is no exception on this score, and since the word "stand" has already been in use, it is perhaps inevitable that "microstand" should be proposed. On the whole, however, he has devoted his attention to clarification of the existing vocabulary.

Since communities are made up of all members of the plant and animal kingdoms, it is understandable that relatively little space has been devoted to fishes, amphibians, or reptiles. Such animals are, of course, mentioned incidentally from time to time, and there are sections that deal specifically with census methods, home ranges, and migrations of the lower vertebrates. The best sources of information concerning amphibians and reptiles are not always cited, but considering the vast literature covered in the book as a whole, Dice will certainly be pardoned for not having exhausted the literature in these restricted fields. He notes in the preface that he cannot attempt to supply a complete bibliography of the literature dealing with communities.

The book contains a wealth of information that any ichthyologist or herpetologist can utilize. Those who recall Dr. Karl P. Schmidt's pointed criticism of ecology in his presidential address to the Society in 1946 will be pleased to observe that Dice belongs to the school of ecologists who call the spade "a spade" rather than a "geotome."—C. M. BOGERT, *American Museum of Natural History, New York, New York.*

THE FROG, ITS REPRODUCTION AND DEVELOPMENT. By Roberts Rugh. The Blakiston Co., New York, 1951: x + 336 pp., 166 figs. $4.25.—This up-to-date and well illustrated basic text on the embryology of *Rana* includes the results of both general and experimental studies, and fills a long-existing need for a modern work in its field. The book is based primarily on the leopardfrog, *Rana pipiens*, but carries some illustrative material on other forms. The broad scope includes the anatomy of the male and female reproductive systems, maturation of the germ cells, fertilization, and development to the early larval stage. The many problems of development are treated much more adequately than is possible in a general text, where the frog inevitably shares space with the chick and pig. An extensive glossary of embryological terms, a bibliography, and an index complete the volume. The abundant illustrations, based on many photographs as well as drawings and diagrams, greatly enhance the value of the book. The well-known figures of stages in normal embryonic development and in the metamorphosis of the leopardfrog are reprinted from Shumway and from Taylor and Kollros. The herpetologist will find various minor irritations in the book, mostly stemming from the differences in training and viewpoint between systematist and embryologist. Unfortunately, the illustrations are not numbered, and some parts of the text appear to have been written in haste.

Although the book is intended primarily as a teaching text, it is also a useful reference for the herpetologist. Modern work in the fields of systematics and evolution has shown clearly that the processes of evolution work upon the entire ontogeny. A thorough knowledge of development is thus an increasingly important tool for the systematist.

Although this useful work gives a detailed treatment of the development of one species of frog, there is still a need for a comprehensive, comparative work on the embryology of the amphibians, at the research and reference level, to bring together the widely scattered literature on the development of the caecilians, salamanders, and frogs. The development of many species departs widely from the classic patterns of *Rana* and *Ambystoma*. Some of the variations are of major phylogenetic importance and some are secondary, associated with specialized habits or habitats, with direct development, or with other factors. It would be of great value both to the embryologist and to the taxonomist to have this material readily available and treated on a thoroughly comparative, critical, taxonomic basis. Furthermore, it would be helpful to extend the discussion of development somewhat farther into the larval stage than is done in the standard embryological textbooks. The early embryology and the adult anatomy of various species are now rather well known, but apparently there is no adequately detailed report on the larval anatomy and metamorphic changes of any species of frog.—GRACE L. ORTON, *Scripps Institution of Oceanography, University of California, La Jolla, California.*

METHODS AND PRINCIPLES OF SYSTEMATIC ZOOLOGY. By Ernst Mayr, E. Gorton Linsley, and Robert L. Usinger. McGraw-Hill Book Co., Inc., N. Y., Toronto, London, 1953: ix + 328, 45 figs. $6.00.—Although few examples are drawn from their fields, ichthyologists and herpetologists will find this pioneering treatise useful. After an introductory section on history, functions, and definitions, it deals primarily with the art of taxonomy—with the collecting and care of specimens; with means of identification, discrimination, and appraisal of relationships; with the selection and interpretation of characters; with quantitative methods of analysis; with the presentation of findings; and with the preparation of taxonomic papers. Particularly timely and thorough is the up-to-date analytical treatment of zoological nomenclature, ending with sound advice on ethics in taxonomy. This book supplements but by no means replaces the modern treatises on speciation and evolution, for it draws from the principles of those basic fields little more than such ideas and definitions as seem to be essential to the art of identifying, naming, and classifying animals, of analyzing their variations, and of preparing the findings for publication. The book is loaded with good ideas, well presented.

Ichthyologists and herpetologists will need to keep in mind, however, that this is a general treatise written by an ornithologist and two entomologists. The methods and principles are in large measure applicable to their work, but the treatment does not cover all of their own special needs. They will wish that more examples had been drawn from publications in their divisions of the science, and they may feel that the book would have been strengthened thereby. It behooves the specialists on cold-blooded vertebrates to be grateful to their distant colleagues and to consider the preparation by themselves of treatises on the methods of collecting, curating, analyzing, and publication that apply particularly to their specialties.

Ichthyologists in particular will be disappointed to see no credit given to Louis Agassiz for having inaugurated at M.C.Z., a full century ago, with fish, the idea of building up large collections of series; and they will feel slighted in noting very few references to the relatively recent extensive work in ichthyology in the fields of zoogeography, geographical variation, population dynamics, natural interspecific hybridization, interrelations between environmental factors and systematic characters, and experimental systematics. These lines of work are not among those most adequately treated in the book, but are among those which could have been strengthened by reference to modern ichthyological work.—CARL L. HUBBS AND ROBERT RUSH MILLER, *Scripps Institution of Oceanography (University of California), La Jolla, California, and Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

FRESH-WATER INVERTEBRATES OF THE UNITED STATES. By Robert W. Pennak. The Ronald Press Co., N. Y., 1953: 769 pp., 470 figs. $14.00.—Thirty-five years have passed since the appearance of a comprehensive treatise on American freshwater invertebrates. The preparation of such an immense task is a tribute to Dr. Pennak, who has emphasized natural history, ecology and taxonomy in this well illustrated source book. For the most part it covers only the free-living invertebrates of the United States, with nearly 180 pages devoted to aquatic insects. Keys to species are provided for the smaller, comparatively stable and better-known taxonomic groups, while the larger groups contain keys to genera only. A list of references, given at the end of each chapter, includes only the particularly significant and comprehensive works, classical as well as recent. At the close of the book are two appendices, one dealing with field and laboratory apparatus and the other with reagents

and solutions, and a comprehensive index of 29 pages. This book should prove to be of particular value to limnologists, fishery biologists and ichthyologists, and of interest to all students of aquatic biology.—ROBERT RUSH MILLER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

GEOGRAPHIC VARIATIONS OF SOME PHYSIOLOGICAL AND MORPHOLOGICAL CHARACTERS IN CERTAIN FRESHWATER FISH. By J. S. Hart. Publ. Ontario Fish. Res. Lab., No. 72, Univ. Toronto Press, 1952: iv + 79, figs. 1–18. $1.50.—The group in Toronto under the leadership of Dr. F. E. J. Fry continues to carry out fundamental research in experimental biology. For his doctoral problem, Dr. J. S. Hart has investigated the relationship between physiological and morphological characteristics for a series of 14 species of fish from Ontario, Ohio, Tennessee and Florida. Lethal temperatures were compared in samples of 10 species from different localities and morphological characters were also studied in 7 of these species. No correlation was found between lethal temperature and morphological traits within the same population. The variability was relatively greater for the morphological than for the physiological characteristics. No evidence was found for physiological as distinct from morphological races, and many of the species studied showed uniformity in their response to lethal temperatures from Ontario to Tennessee or Florida. Lethal temperature findings did not confirm the accepted taxonomic status of *Notemigonus crysoleucas* or *Rhinichthys atratulus* from Toronto and Florida and Toronto and Knoxville, respectively. Physiological and morphological findings were in harmony for *Notropis cornutus*, *Gambusia affinis* and *Micropterus salmoides*. Upper lethal temperatures were correlated with habitat, since eurythermal species occurred in southern localities and in ponds or base-level streams whereas the more stenothermal species were found in northern, cooler habitats. However, southern forms of species were not more resistant to high temperatures than northern forms, and vice versa.

Fishes studied included *Dorosoma cepedianum*, *Notemigonus crysoleucas*, *Semotilus atromaculatus*, *Rhinichthys atratulus*, *Notropis atherinoides*, *Notropis cornutus*, *Pimephales notatus*, *Ameiurus natalis*, *Ameiurus nebulosus*, *Ictalurus punctatus*, *Gambusia affinis*, *Perca flavescens*, *Micropterus salmoides*, and *Lepomis macrochirus*. The races studied do not appear to be exposed to temperature extremes of sufficient geographic magnitude to bring about selection for temperature resistance. Moreover, the lethal temperatures are evidently well above the thermal extremes commonly met with by these species and are interpreted as having little ecological significance.

This important paper will repay careful study by the systematist as well as the physiologist.—ROBERT RUSH MILLER.

BETWEEN THE TIDES. By Philip Street. Philosophical Library, N. Y., 1953: 1–175, 41 figs., 74 photographs. $4.75.—One of the great fascinations of the seashore is the myriad forms of life that exist between high and low tide. Written primarily for the young or beginning naturalist, this book is not a guide to seashore animals but rather provides a carefully written, simple introduction to the common types of shore animals and their conspicuous plant associates. Emphasis is on natural history, but the appearance and detailed structure of many of the plants and animals treated are well portrayed by line drawings and photographs. The book is intended to stimulate the reader to further study by opening his eyes to the rich storehouse of seashore life, and this aim is successfully accomplished.—ROBERT RUSH MILLER.

EDITORIAL NOTES AND NEWS

SUMMARY OF 1953 MEETING

THE 33rd annual meeting of the ASIH was held in New York City, April 22–26, 1953. The American Museum of Natural History and the New York Zoological Society jointly sponsored the meetings.

ACTIVITIES OF APRIL 22

The Board of Governors' meeting, held in the Henry Hudson Hotel, was called to order by PRESIDENT CHARLES M. BOGERT at 8:15 PM. Twenty-two Governors were present. The reading of the minutes was dispensed with and approved as printed in COPEIA, 1952 (3): 214–20.

The following persons were elected to fill vacancies in the Board of Governors: JOHN TEE-VAN, ROBERT HARRY, ROBERT DENISON, JAMES ATZ, GRACE ORTON, LEONARD SCHULTZ, W. I. FOLLETT, JAMES PETERS, BOBB SCHAEFFER, and WILLIAM

STICKEL. A vacancy in Honorary Foreign members was filled by the election of WALTER HELLMICH.

DR. J. C. DICKINSON, of the University of Florida, was present at the Board of Governors' meeting for instructions since he was to serve as the Society's delegate to the meeting of the National Research Council and the American Institute of Biological Sciences on the 23rd and 24th of April in Washington, D. C.

DR. SAMUEL MEYER, Executive Director of the AIBS, was present and spoke to the group briefly. After considerable discussion, including consideration of the results of the membership ballot regarding continuation of our affiliation with AIBS, DR. OLIVER moved that we vote on the kind of affiliation that we want with AIBS, if any. His motion was to limit discussion and call for the question. DR. CARL HUBBS moved that the ASIH maintain its present affiliation, that is, full membership with the AIBS; this was passed by a vote of 16 to 6.

DR. COOPER then gave a detailed report on the publication of COPEIA, comparing the advantages and disadvantages of Waverly Press performance with that of the Ann Arbor Press. He also presented some figures showing the possible costs of having the journal set up in lithoprinting. Lithoprinting cost would run about $400 less per number than printing. MR. NETTING moved that we table discussion of lithoprinting and give a vote of thanks to MRS. GAIGE and DR. COOPER for the very careful work they had done in studying these publication costs. The motion was passed. DR. CARL HUBBS then moved that the Editor be empowered to contract for the best possible bargain he can obtain regarding the printing of COPEIA. This was passed.

MR. GREEN gave a report on the sale of back numbers and the problem of replacing, either by purchase or reprinting, missing numbers. After much discussion, MR. NETTING moved that the Publications Secretary be empowered to invest 20 percent of the previous year's income from sale of back numbers for the purpose of lithoprinting exhausted stocks. This was passed. A vote of thanks was given to the Publications Secretary for the excellent work he had done in the Society's behalf.

DR. RANEY moved that the initial $2,085.49 first earned by the Check List be put back into the endowment fund from which it was borrowed. The motion was passed.

PRESIDENT BOGERT, in the absence of MR. STOYE, read the report of the Revolving Research Fund which showed that three (3) outlays had been made this year. The fund is now down to about $600.

DR. GOIN reported on the COPEIA endowment fund.

DR. DAVIS reported on the progress of the Check List indicating that it was then past galley proof and was entering page proof. He reported that it might be possible to sell the Check List for around $2.50 a copy. The Governors recommended that about $.50 more be added to the price, so that a small profit might be realized. An edition of about 2,000 was planned.

PRESIDENT BOGERT made reference to DR. WALFORD's report on the October, 1952, meeting of the Agricultural Research Institute and advised the Governors that it was available for their study.

MR. CONANT moved that the Society give 40 pounds to help with the publication of the *Zoological Record*. This was passed.

DR. GOIN presented the Treasurer's report made out by DR. WEBSTER. It was adopted.

There was discussion of the problem of affiliation with the American Association for the Advancement of Science. DR. RANEY moved that the ASIH affiliate with the AAAS. The motion was passed.

The Governors decided to accept the invitation made earlier by DR. MEYER that the ASIH meet with the AIBS in Gainesville, September, 1954.

DR. FOLLETT invited the ASIH to meet in California in the Spring of 1955. There was general agreement although no formal action was taken.

DR. YERGER, President of the Southeastern Society of Ichthyologists and Herpetologists, presented that group's petition for affiliation with the ASIH as a Southeastern Division. This was in the form of a constitutional amendment. MR. NETTING moved that the Constitution be so amended to include the Southeastern Division. This was passed unanimously.

PRESIDENT BOGERT suggested a redefinition of the terms of officers to coincide with the calendar year. DR. OLIVER moved that the Constitution be so amended. This was passed.

The Secretary pointed out the difficulties encountered in handling subscriptions to COPEIA, particularly when subscription agencies were involved. He also pointed out the difficulties inherent in the problem of billing on the forms of the recipient institutions. He suggested that the subscription to COPEIA be changed to $7, with a $1 discount for bills rendered on Society forms. DR. R. M. BAILEY moved accordingly. This was passed. DR. COOPER moved that the single issue price of COPEIA be raised to $2. This was also passed.

The amount of financial support to be given to secretaries of divisions of the ASIH was discussed. It was pointed out that in the past the Western Division was allowed to draw upon the national treasury up to $.25 per member. It was further pointed out, however, that the Western Division rarely used any of these monies and only occasionally asked for $10 or $15 dollars for postage. It was moved by MR. NETTING that hereafter no funds be made available for divisional use. This was passed.

The problem of emeritus members was discussed, and MR. CONANT moved that the Secretary be

permitted to continue as emeritus members those members who applied for such status. This was passed. The idea was to give this status only when requested, to include only persons who had been members of the Society before life memberships were available, and to provide a subscription to COPEIA.

The problem of the large number of requests received by the Secretary for occupational information in herpetology and ichthyology was discussed. It was suggested that such letters be referred to the AIBS. It was pointed out by the Secretary that statements should be drawn up by the ASIH for the AIBS to use as tear sheets. PRESIDENT BOGERT appointed a herpetologist and an ichthyologist to prepare such statements of occupational information. DR. CAGLE was asked to prepare a statement giving occupational information in herpetology; and MR. WOODS for ichthyology.

DR. RANEY gave a report on the work of the AIBS as he saw it while serving on the Governing Board of that institution, representing the ASIH.

There was considerable discussion concerning a redefinition of the functions of the Treasurer. It seemed fairly well agreed that the division of work between the Treasurer and Secretary was quite uneven and that the position of Secretary carried an unusual amount of work. It was suggested that the Treasurer might handle some of this work, and it was also suggested that the Secretary's work be divided between a financial secretary and a corresponding secretary. No action was taken at this meeting. The Treasurer was authorized to be the agent to sell and disperse the Check List. (The Check List Committee, including the Treasurer and the Publications Secretary, later agreed to have the Check List distributed from the office of the Publications Secretary.) There being no further business, the Board of Governors' meeting was adjourned at 12:05 AM, April 23rd.

ACTIVITIES OF APRIL 23

Registration began at 9:00 AM in the Roosevelt Wing of the American Museum of Natural History. A registration fee of $1.00 was charged. Total registration was 136 persons representing 20 states and 2 foreign countries. Outside of the host state, the largest numbers of registrants were from Florida and Pennsylvania. At least five persons were registered from each of the following additional states and countries: Canada, California, Illinois, Massachusetts, Michigan, and New Jersey.

The first formal session was convened about 10:30 AM by PRESIDENT BOGERT. DR. ALBERT E. PARR, Director of the American Museum of Natural History, gave an address of welcome to about 100 members and guests. The following papers were presented:

Differential effects of light and temperature on gametogenesis and reproduction in the centrarchid fish, Enneacanthus obesus (Girard).—Robert W. Harrington, Jr.

Morphological effects of castration and hormone replacement therapy in the cichlid fish, Tilapia macrocephala.—Madeline Levy.

The role of oral incubation in Tilapia macrocephala.—Evelyn S. Shaw and Lester R. Aronson.

Viviparous caecilians.—E. R. Dunn and H. W. Parker.

Eating of frog eggs, by tadpoles of Anotheca coronata.—Edward H. Taylor.

After lunch, further papers were presented, with EDWARD C. RANEY presiding over the sessions. About 80 persons were present and the following papers were given:

The chromosomes of plethodontid salamanders.—James Kezer.

Embryonic abnormalities in reciprocal hybrids of Mexican and Wisconsin Rana pipiens.—E. Peter Volpe.

Burrowing behavior of the sand viper, Cerastes vipera.—D. Dwight Davis.

The function of the teleost ultimobranchial gland.—Priscilla Rasquin and Libby Rosenbloom.

Natural history of Hippocampus zosterae at Cedar Key, Florida.—Kirk Strawn.

Graphical analysis and comparison of series of samples.—Carl L. Hubbs and Clark Hubbs.

Ecological relationships of the North Polar pack ice, with particular reference to the fishes.—Norman J. Wilimovsky.

There then followed the annual business meeting which convened at 4:15 PM. PRESIDENT BOGERT was in the chair and 75 members were present.

The minutes for the 1952 annual meeting, having been published in COPEIA 1952, No. 3, were accepted as printed. The Secretary was called upon to give a report. He first reported upon the Board of Governors' meeting, outlining some of the highlights and some of the actions of that meeting. He then reported upon the growth of the membership, pointing out that there had recently been a decrease of about 100 members. This was the result of the Secretary's following the Constitutional provision that dues are payable on or before the first of the year.

Since a constitutional amendment requires both Board of Governors and business meeting approval, the Society then acted upon the Constitutional amendments that were passed by the Board or Governors the preceding night. It was moved by the Secretary and passed unanimously by the Society that the Constitution be amended by the addition of a new article as follows:

ARTICLE IX: SOUTHEASTERN DIVISION.

Section 1. The Southeastern Division shall consist of those members from Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and the District of Columbia.

Section 2. The Southeastern Division shall elect

its own officers (President, Vice-President, and Secretary-Treasurer) and hold annual meetings.

It was moved by the Secretary and passed unanimously by the membership that ARTICLE IV, Section 2, of the Constitution be amended so that the last sentence is changed to read: "The term of office shall commence on January 1, following the annual meeting at which the officers were elected."

In like manner, the By-Laws were amended so that ARTICLE I, Section 4 now reads: "The annual subscription rate for COPEIA shall be $7. A discount of $1 will be allowed to those subscribers billed on Society forms." This is to take effect in 1954.

DR. GOIN gave the report of the retiring Treasurer as follows:

Financial Report for Calendar Year 1952
By D. A. Webster, Retiring Treasurer

RECEIPTS

Memberships received		
Current dues for 1952	$3133.68	
Back dues for 1951 and before	34.50	
Advance dues for 1953 and beyond	2562.70	$ 5730.88
Subscriptions received		
Current, for 1952	799.50	
Back, for 1951 and before	15.00	
Advance, for 1953 and beyond	1280.40	2094.90
Reprints paid for (reimbursements for bills paid)		346.06
Back numbers of COPEIA sold (from Publications Secretary)		1011.57
Miscellaneous receipts		38.86
Contributions		
Anonymous (specified £10 to Zoological Record)	30.00	
CARL HUBBS (prizes, Ich. papers, West. Div.)	40.00	
GEORGE MEADE (towards publication of Herp. check list)	500.00	
From members (towards publication costs)	61.50	631.50
Interest of F. H. Stoye Fund (to be used for prizes)		75.00
		$ 9928.77
Transfer of Endowment balance, January 1953, as per instructions from Society, to help meet publication costs of Herp. check list		2085.49
Total Receipts		$12014.26

EXPENDITURES AND DISBURSEMENTS

Cost of publication of COPEIA		
COPEIA 1951, No. 4	$1590.10	
COPEIA 1952, No. 1	1368.95	
COPEIA 1952, No. 2	1285.03	
COPEIA 1952, No. 3	1882.38	$6126.46
Reprint costs (will be returned to Society)		
COPEIA 1950, No. 4	272.24	272.24
Printing		507.01
Stenographic services		80.00
Postage		
Secretary (Gainesville)	100.00	
Editor (Ann Arbor)	100.00	
POPE	16.00	216.00
Annual meeting in Austin		
Expenses of Secretary		180.00
Prizes awarded at Annual and Western Division Meetings		
KIRK STRAWN	$25.00	
JOHN MECHAM	25.00	
A. B. RECHNITZER	25.00	
PAUL MARTIN	15.00	
CONRAD LIMBAUGH	7.50	
R. E. NOBLE	7.50	$105.00
Contributions		
Remittance of 50 pounds to Zoological Society of London to assist in publication of 1951 Zoological Record		140.38
Publication of Herpetological Check list		3864.00
Binding 15 volumes of ASIH set of COPEIA		46.90
Dues		
American Institute of Biological Sciences, 1952		814.00
Miscellaneous debits and refunds		47.40
Total Expenditures and Disbursements		12399.39
Excess expenditures over receipts		385.13
		12014.26

Balances on hand December 31, 1952

Checking Accounts		
Transferred to new Treasurer from First National Bank, Ithaca, N. Y.		832.13
On deposit in Citizens' Bank, Gainsville, Florida		2216.33
Total Checking		3048.46
Endowment Fund		
Transferred to new Treasurer from Ithaca Savings & Loan Assn		$2085.49
On deposit First Federal Savings & Loan, Gainesville, Florida		175.00
		2260.49
4 Series *G* U. S. Savings Bonds, maturity value		4000.00
Revolving Research Fund		
Transferred to new Treasurer from Tompkins Co. Trust Co., Ithaca		970.25
F. H. Stoye Fund		
4 Series *G* U. S. Savings Bonds, maturity value		3000.00

DR. CARR reported for the Auditing Committee consisting of MR. ROSS ALLEN and himself, approv-

ing the method of handling of the books by the Treasurer.

There then followed a number of committee reports. DR. FOLLETT made a brief report of the committee working on zoological nomenclature. DR. DAVIS gave a brief report for the Check List Publication's Committee. DR. INGER gave a report on the possibility of obtaining clamp-type jars, of the ½ pint size, from various European manufacturers. One shipment has reached the United States National Museum from Japan. DR. FOLLETT suggested that the Secretary write to the AIBS asking them to serve as a clearing house for this kind of operation. DR. CARL HUBBS reported on the National Speleological Society's forthcoming publication of occasional papers.

The nominating committee, with DR. SCHULTZ as Chairman, then presented a slate of nominees for all offices except President. The office of President is to be held by the incumbent for one more year. There were no nominations from the floor and the persons nominated were duly elected. Their term of office will commence on January 1, 1954. The new officers will be: Vice-Presidents: for Conservation, JOHN TEE-VAN; for Finance, GEORGE P. MEADE; for Membership, REEVE M. BAILEY; Treasurer, COLEMAN J. GOIN; Secretary, ARNOLD B. GROBMAN; Editor in Chief, GERALD P. COOPER; Ichthyological Editor, ROBERT R. MILLER; Herpetological Editor, NORMAN HARTWEG; Editorial Board (five members), EARL S. HERALD, ERNEST A. LACHNER, WILLIAM A. GOSLINE, ROBERT W. STEBBINS, and FRED R. CAGLE. The meeting was adjourned at 5:10 PM.

The feature of the evening was a smoker in the new Brontosaur Hall given through the courtesy of the American Museum of Natural History. During the early part of the evening the following two demonstration papers were presented:

Hereditary differences among seven geographical populations of a single species of platyfish.—Myron Gordon.

The fish fauna of the Middle Eocene Green River Formation.—Bobb Schaeffer and David H. Dunkle.

ACTIVITIES OF APRIL 24

During the morning, separate sessions were held for herpetology and ichthyology. DR. CARL HUBBS presided over the ichthyological session at which forty members were present. The following papers were presented:

A comparison of several populations of striped bass, Roccus saxatilis, with reference to racial investigations.—Edward C. Raney and Donald P. de Sylva.

River sturgeons of the American genus Scaphirhynchus: distribution, characters, and synonymy.—Reeve M. Bailey and Frank B. Cross.

Anatomical distinctions between three eastern North American species of sturgeon (Acipenser).—Vadim D. Vladykov.

Tentative taxonomy of ammocoetes of the genus Ichthyomyzon.—Vadim D. Vladykov.

Ecological notes on the fishes of a short coastal drainage in North Borneo.—Robert F. Inger.

An analysis of the competitive feeding habits of two benthic stream fishes.—Franklin C. Daiber.

A study of the quantity of chitin present in insects and its influence on the digestive rates of fishes.—Franklin C. Daiber and Wallace F. Henion.

The pharyngeal teeth of Semotilus.—Howard E. Evans.

The herpetological session was presided over by MR. NETTING. About fifty persons were present to hear the following papers:

Herpetogeography of the central Gulf Coast region.—Wilfred T. Neill.

Relationships between the genera in the lizard family Zantusiidae.—Jay M. Savage.

The status of the Mexican geckos of the genus Sphaerodactylus.—Hobart M. Smith.

Remarks on the snake genus Chironius in the southeastern portion of its range.—Joseph R. Bailey.

A study in taxonomic procedure—the subspecies of Dipsas indica Laurenti.—James A. Peters.

Dendrobatid frogs.—E. R. Dunn.

A taxonomic study of the frogs allied to Hyla venulosa.—W. E. Duellman.

A preliminary study of geographic color variation in Plethodon glutinosus.—Richard Highton.

The distribution of Eurycea l. longicauda and E. l. guttolineata in Fairfax County, Virginia.—James A. Fowler.

Ambystoma t. tigrinum on the eastern shore of Maryland.—C. J. Stine, Jr. and James A. Fowler.

The amphibians of Maryland. C. J. Stine, Jr. and James A. Fowler.

At noon, a group photograph was taken on the south steps of the Museum under the direction of MRS. BESSIE HECHT. Additional copies of this photograph may be obtained from MR. LEON BOLTIN of the American Museum of Natural History at one dollar each.

At the beginning of the afternoon the following paper was presented:

Orientation in schooling fishes.—James Atz.

There was then a meeting for the purpose of having an open discussion on fish nomenclature and for hearing a report of the Committee on Zoological Nomenclature. DR. REEVE BAILEY presided, and MR. WILIMOVSKY acted as secretary. About 75 members were present. Following introductory remarks, DR. FOLLETT, Chairman of the Committee on Nomenclature, reported on the current activities of the Committee and reminded members of the Fourteenth International Congress of Zoology to be held in Copenhagen, August 5–12, 1953. Members of the Society were urged to communicate with DR. FOLLETT, who will attend the Congress, regarding matters they wish raised before the International Commission on Zoological Nomenclature. DR. FOLLETT also exhibited and discussed his recent digest of the nomenclatorial enactments of the

1948 Paris Congress. This was prepared for use of the Committee in their deliberations and is not available for distribution. MR. WILIMOVSKY was called upon for a subcommittee report on the status of the ichthyological names proposed in Oken's *Lehrbuch*. In the ensuing discussion no objection was raised to a tentative proposal that the names be declared unavailable from a nomenclatorial standpoint, as had previously been done for bird and mammal names published in the same work.

The question of restriction of type localities, raised by HOBART M. SMITH'S recent article (*Syst. Zool.*, 1953, 2 (1): 37), was debated heatedly and at length. A suggestion that the Commission prepare recommendations (as contrasted with definite rules) relating to this problem met with considerable favor.

DR. FOLLETT sought counsel from the membership on its attitude toward the question of page and line priority (as invoked by the International Congress in 1948) *vs.* selection by first reviser (as heretofore recognized in the International Rules of Zoological Nomenclature), to determine the valid name among two or more proposed as new in the same publication but which are later shown to apply to the same taxonomic unit. After protracted discussion a tally showed 29 members favoring the principle of the first reviser, 4 persons in favor of the 1948 enactment of the principle of page and line priority. Of 28 members committing themselves on a future course of action, 25 indicated their willingness to abide by the decision of the forthcoming Congress. Further discussion of similar problems was prevented by an overfull agenda.

DR. REEVE BAILEY introduced a request for reconsideration of the nomenclature of the higher groups of fishes, previously acted on at the Salt Lake City meeting (COPEIA, 1950, 4: 326–27). [At this point most of the herpetologists left the room to hold a meeting on common names of amphibians and reptiles.] DR. BAILEY reviewed a letter that he had sent to some 60 American ichthyologists. Tabulation of the returns of the questionnaire that accompanied the letter revealed general dissatisfaction with many of the decisions reached at the 1950 meeting.

On the STENZEL system of terminations for groups from subtribe to superorder, opinions expressed in the letter ballot were as follows:

For continuation without modification	1
For continuation of a modified version	1
For outright revocation	28
No vote	3

A query, as to preference on how high in the hierarchial ranks it is desirable to form names by addition of a suffix to the stem of an included generic name, resulted in the following:

Superfamily	4
Suborder	3
Order	19
Superorder	2
No vote	5

The vote for preferences in terminations for the several categories was:

Rank	*Suffix*	*For*	*Against*
Superorder	ica	2	26
Order	formes	17	8
Suborder	oidei	17	6
Superfamily	oidea	21	2
Tribe	ini	18	2

The results on these questions are in close agreement with the replies received by DR. SCHULTZ to a similar set of questions sent out in 1949 not only to ichthyologists but to all members of the Society of Systematic Zoology (*Science*, 1951, 113: 655).

When asked to express a choice between names for the group that includes the Recent Agnatha, 22 persons indicated their preference for Cyclostomata, 3 for Cyclostomi. Previously (COPEIA, 1950, 4: 327) the Committee on Fish Classification had ranked this group as a subclass under the name Cyclostomi. It was indicated in discussion that Cyclostomata is used also as an ordinal name in the Bryozoa. [Cyclostomi apparently dates from Bonaparte, 1832. Cyclostomata was used in the Agnatha at least as early as 1836 by Schinz, and thus has priority over Cyclostomata Busk, 1852, in Bryozoa. This information was not made available on the questionnaire. —R.M.B.]

It should be noted that the above results from the questionnaire are unofficial. They are intended to be instructional to the Committee on Nomenclature. DR. SCHULTZ objected to this procedure by pointing out that technical matters should not be settled by popular vote.

DR. CARL HUBBS presented a proposed modification of the STENZEL system which eliminates features in the original plan that have been criticized by a number of authors, especially in the pages of *Systematic Zoology*. He then reviewed the hurried nature of the discussion which led, in 1950, to adoption of the STENZEL system, and he urged that we now avoid repetition of the earlier haste in arriving at decisions. The primary improvements of the emended system over the STENZEL system are: (1) the substitution of the more euphonious "l" for "c" in the terminations of supertribe, superfamily, and superorder; and (2) the modification of suffixes so that the adjectival forms are all different. The accompanying table permits comparison of the suggested sets of terminations to be added to generic stems.

Rank	Stenzel system		Proposed modification of Stenzel system		Proposed modification of Berg system	
	Termination	Adjectival suffix	Termination	Adjectival suffix	Termination	Adjectival suffix
Subtribe	ini	(in)	ani	(an)	ina	....
Tribe	idi	(id)	adi	(ad)	ini	(in)
Supertribe	ici	(ic)	ali	(al)	idi	....
Subfamily	inae	(ine)	inae	(ine)	inae	(ine)
Family	idae	(id)	idae	(id)	idae	(id)
Superfamily	icae	(ic)	ilae	(il)	oidea	(oid)
Suborder	ina	(ine)	oinei	(oin)	oidei	(oid)
Order	ida	(id)	oidei	(oid)	(i)formes	(form)
Superorder	ica	(ic)	oilei	(oil)	....	....

In a call for an expression of opinion on the continuation of the STENZEL terminations, 9 members of the Committee on Fish Classification (in attendance: BAILEY, HUBBS, RANEY, SCHULTZ, and TEE-VAN; by proxy: DENISON, MYERS, PARR, and SCHAEFFER) voted unanimously to abandon the system; among the members present the vote was 27 to 0 for revocation. Thus, the unmodified STENZEL system was abandoned by the Society. In order to allow time for thorough consideration of alternative systems, decision on a substitute plan was postponed until the next annual meeting, or until the Committee on Nomenclature can take action. Interested members are urged to communicate their views to CHAIRMAN FOLLETT of the Committee (California Academy of Sciences, Golden Gate Park, San Francisco 18, California).

Several members expressed dissatisfaction with the lack of progress in development of a Classification for the Fishes of the Western North Atlantic, but despite a general recognition of urgent need no concrete proposals for action were forthcoming.

Because of the late hour the planned discussion of problems of the Committee on Common Names was dispensed with and the meeting was adjourned.

The open discussion on herpetological common names was held in another room. Under the chairmanship of DR. HOBART M. SMITH, this meeting convened at 4:15 PM. After brief discussion, the group present expressed an overwhelming approval of continued effort by the Society to effect uniformity in common names. Action on individual names was postponed in order to have available the new Check List with its common names, alterations to be proposed by the committee members, and any others interested. The principles guiding selection and construction of common names were read, but approval by members of the Society was deferred until the Gainesville meeting.

At 7:00 PM the annual banquet was held in the Terrace Room of the Henry Hudson Hotel. There was some desultory group singing led by KARL LAGLER, COLEMAN GOIN, DWIGHT DAVIS, and MICKEY BOGERT. CHARLOTTE RANEY was the accompanying pianist. The group was then privileged to see two fine motion pictures produced by the New York Zoological Society. The first film, "Life of the Waters," was a preview of the new New York Aquarium that is being planned for Coney Island. The second, "Locomotion of Snakes," is one of a series on the biology of reptiles. A highlight of this film was an x-ray motion picture which clearly showed that snakes do not "walk on their ribs" during rectilinear or caterpillar locomotion.

ACTIVITIES OF APRIL 25

At 8:45 AM two large buses, provided through the courtesy of the New York Zoological Society, met members at the Hotel and Museum and took them to the N. Y. Zoological Park. Formal sessions were convened in the Administration Building with DR. GROBMAN presiding. About 125 members and guests were present.

FAIRFIELD OSBORN, President of the N. Y. Zoological Society, gave an address of welcome to the Park. As part of his address he discussed briefly some of the world population and conservation problems. There then followed a joint session of papers as follows:

Unusual causes of death in fishes.—Ross Nigrelli.

The life history of the slimy salamander (Plethodon glutinosus) in Florida.—Richard Highton.

The vital limits of desiccation in salamanders.—G. Carleton Ray.

Home range and homing behavior in Hyla crucifer.—David Delzell.

Present status of the "Fishes of the Western North Atlantic" —John Tee-Van.

Development of lateral-line scales in Etheostoma lepidum and E. grahami.—Clark Hubbs.

The perception of low frequency vibrations in Semotilus a. atromaculatus (Mitchill).—H. Kleerekoper.

Electrical characteristics of the electric eel and Gymmotus carapo (Demonstration.)—Christopher W. Coates, Mario Altamirano-Orrego, and M. Vertner Brown.

At 1:00 PM members and their guests were luncheon guests of the N. Y. Zoological Society. A very pleasant out-of-door lunch was held at the "Zoobar."

At the end of the lunch, the Fred H. Stoye Prize Committee presented checks as awards for the best student papers given at the meetings. The best student paper in ichthyology was judged to be "Ecological relationships of the North Polar pack ice, with particular reference to the fishes" by NORMAN J. WILIMOVSKY of Stanford University. Two prizes were given in herpetology. One went for the

paper "Relationships between the genera in the lizard family Xantusiidae" by JAY M. SAVAGE of Stanford University; and the other for "The life history of the slimy salamander (Plethodon glutinosus) in Florida" by RICHARD HIGHTON of the University of Florida.

DR. GROBMAN then made an announcement about the next annual meeting to be held at the University of Florida in September, 1954, in conjunction with the American Institute of Biological Sciences. He pointed out that weather conditions at that time of the year are quite variable and may be rather hot. The suggestion was made that members plan on informal dress, with open-collared sport shirts being recommended.

The following report was presented by the Resolutions Committee:

Whereas, the thirty-third annual meeting of the American Society of Ichthyologists and Herpetologists, held at the American Museum of Natural History, and at the New York Zoological Park, from April 22 through April 26, 1953, has been successfully completed;

Therefore, be it resolved: (1) That the members of the Society express their appreciation for the unlimited courtesy and hospitality extended to them by the *local committee:* ROSS NIGRELLI (Chairman), JAMES ATZ, C. M. BREDER, CHRISTOPHER COATES E. H. COLBERT, MYRON GORDON, BESSIE HECHT, FRANCESCA LAMONTE, JAMES A. OLIVER, BOBB SCHAEFFER, JOHN TEE-VAN, and the wives of same, as well as their other assistants.

(2) That JAMES A. OLIVER, Chairman of the Program Committee, be thanked for his success in arranging a splendid program of scientific papers.

(3) That we owe special thanks to the officials of the American Museum of Natural History for their hospitality and the use of their many facilities.

(4) That we thank CARL KAUFFELD for the invitation to visit the Staten Island Zoo.

(5) That we extend our thanks to FAIRFIELD OSBORN for making it possible for so many members to visit the New York Zoological Park and enjoy the hospitality extended to us there; and to JOHN TEE-VAN and his staff for the unusually excellent movies viewed at the banquet.

(6) That we express our thanks to WILLIAM BRIDGES, editor and curator of publications of the New York Zoological Society, for his untiring efforts in preparing the printed program of the Society's meeting.

Whereas, the Society, sensible of the loss of one of our distinguished and honored foreign members: LORENZ MÜLLER;

Therefore, be it resolved: that the Society Secretary, ARNOLD GROBMAN, be requested to write a letter of condolence to his bereaved family.

MR. TEE-VAN then invited the group on a tour of the Park. Travel was via the Zoo's comfortable tractor-trains. In addition to visiting the new Penguin and Great Apes houses, the group also spent some time in the Reptile House which is being completely remodeled. Because of this, the labels normally accompanying the cages were gone and so the herpetologists were able to display their considerable erudition to the ichthyologists. One of the highlights of the visit to the Reptile House was the opportunity to see the living specimen of *Sphenodon*, which was robust and comparatively lively. Another highlight was the view of CARR, CONANT, and OLIVER in the turtle pit vying with the turtles for the approbation of the crowd.

The tour visited the Lion House which was of particular interest to members of the Society because its long west wall has been given over to aquaria. The ichthyologists were at a distinct disadvantage in displaying their erudition to the herpetologists because the aquaria were well labeled, a new style of label having been recently installed.

After the tour, the buses returned the members to the hotel.

The Secretary appreciates the help given in the preparation of this report by DR. REEVE M. BAILEY and DR. HOBART M. SMITH.—ARNOLD B. GROBMAN, *Secretary*.

News Notes

DR. GEORGE K. REID, JR., who recently completed his doctorate at the University of Florida, spent the summer studying fish behavior at the Virginia Fisheries Laboratory. On September 1, he began his new assignment as Assistant Professor in the Department of Wildlife Management, Texas A. and M. College, College Station, Texas.

The U. S. Department of Health, Education, and Welfare has announced the following: Twenty-three training courses in various aspects of environmental sanitation will be conducted by the Environmental Health Center of the Public Health Service at Cincinnati, Ohio during the period July 1, 1953 to June 30, 1954. The short courses are given for professional personnel from State and local health departments, water pollution control agencies, the Public Health Service, other governmental units, educational institutions, and industries cooperating with these agencies in environmental sanitation programs. The schedule includes advanced training in chemical, bacteriological, biological and engineering aspects of stream and industrial waste surveys for water pollution control, and short courses dealing with special problems in water and industrial waste analyses, water supplies, sewage disposal, milk and food sanitation, radiological health, and occupational radiation protection. A bulletin de-

scribing the 23 courses is available upon request from the Officer in Charge, Environmental Health Center, Public Health Service, Department of Health, Education, and Welfare, Cincinnati 2, Ohio.

On June 25, 1953, the Max C. Fleischmann Foundation of Nevada gave a grant-in-aid to the University of California (Berkeley) for the Sagehen Creek Project in the amount of $30,000. The wording of the grant is broad, leaving full latitude to the University in the use of the fund. This project is under the direction of DR. PAUL R. NEEDHAM. Sagehen Creek is fourteen miles north of Truckee, California, at an elevation of 6,600 feet. The program under way there contemplates year-round studies of cycles in fish populations and allied problems, and the Fleischmann grant will go a long way toward furthering efforts under this project.

DR. MAX M. ELLIS died on August 26, 1953, at Los Angeles, California, at the age of 65. He was on a year leave of absence from the University of Missouri. For many years prior to 1947, DR. ELLIS was an investigator for the United States Bureau of Fisheries and the United States Fish and Wildlife Service. Among his most noteworthy contributions in fisheries are: Fishes of Colorado (1914), Detection and Measurement of Stream Pollution (1937), and Determination of Water Quality—coauthor with B. A. Westfall and M. D. Ellis (1946).

The sixth edition of the CHECK LIST OF NORTH AMERICAN AMPHIBIANS AND REPTILES is off the press. This edition, prepared by KARL P. SCHMIDT and printed by the University of Chicago Press, runs to 280 pages and is bound in red cloth. A few copies were left in loose sheets for those who wish to interleave and bind their own. The Publication Committee for the Check List consisted of D. DWIGHT DAVIS, COLEMAN J. GOIN, and GEORGE P. MEADE. The Check List may be ordered at $3.50 per copy, bound or unbound, postpaid, from the Publications Secretary, N. BAYARD GREEN, Marshall College, Huntington, West Virginia.

Gift MR. GEORGE P. MEADE, of the Colonial Sugars Company, Gramercy, Louisiana, presented the Society with a gift of five hundred dollars toward the cost of publishing the Check List of North American Amphibians and Reptiles.

SWAN The Southwestern Association of Naturalists was formed at an organizational meeting attended by fifty-two persons at the University of Oklahoma Biological Station at Lake Texoma on May 23, 1953. As stated in the constitution, "The object of the Association shall be to promote the field study of plants and animals, living and fossil, in the Southwestern United States and Mexico, and to aid the scientific activities of its members." SWAN hopes to stimulate the study of the region by bringing together persons of like interests through publication of annotated membership lists, annual meetings, and perhaps later through the publication of a journal. The officers elected for the first year were: W. FRANK BLAIR, (Vertebrate Zoology) University of Texas, *President*; GEORGE J. GOODMAN, (Plant Taxonomy) University of Oklahoma, *Vice-President*; HERNDON G. DOWLING, (Herpetology) University of Arkansas, *Secretary-Treasurer*. The geographic scope of the Association at present includes Mexico and the states of Arizona, Arkansas, Kansas, Louisiana, New Mexico, Oklahoma, and Texas. Persons interested in the natural history of this region are invited to join the Association. Membership blanks may be obtained from any of the officers.

Western division The 22nd annual meeting of the ASIH, Western Division, was held on June 16–18, 1953, at Santa Barbara, California, as part of the annual meeting of the Pacific Division of the AAAS. In ichthyology, there were two half-days of submitted papers, and in herpetology, one half-day of submitted papers. In addition, there was a symposium, "Some Major Research Needs in Ichthyology and Herpetology."

Student awards in ichthyology were: *first*, to KENNETH S. NORRIS, Scripps Institution of Oceanography, La Jolla, for a paper on "The Importance of Temperature in the Habitat Selection of Intertidal Fishes"; *second*, to GEORGE C. WILLIAMS, University of California, Los Angeles, for a paper on "Home Tide-pool Discrimination in *Girella nigricans*."

Student awards in herpetology were: *first*, to WILLIAM J. RIEMER, University of California, Berkeley, for a paper on "The Annual Activity Cycle of the Salamander, *Triturus torosus*"; *second*, to BAYARD H. BRATTSTROM, University of California, Los Angeles, for a paper on "The Reptiles and Amphibians of Rancho La Brea."

At the business meeting, the following officers were elected:

President, W. A. CLEMENS, University of British Columbia, Vancouver.

Vice-President, RICHARD C. SNYDER, University of Washington, Seattle.

Secretary-Treasurer, ANITA E. DAUGHERTY, California State Fisheries Laboratory, Terminal Island.

It was voted to extend an invitation to the national society to meet on the west coast in 1955.—ANITA E. DAUGHERTY.

INDEX TO SCIENTIFIC NAMES

1953, Nos. 1-4

New names and their principal references are printed in bold face type

abditum, Pisidium, 60
Acantharchus, 117–9
  pomotis, 117–8
Acanthias, 142
  vulgaris, 142
Acanthodactylus tristami, 66–7
    orientalis, 66
Acanthophis antarcticus, 167
Acara coeruleopunctata, 146
Acer macrophyllum, 42
Acrantus viridis, 125
Acris crepitans, 187, 208
  gryllus gryllus, 59
acuminata, Populus, 180
acus, Fierasfer, 222
acutus, Crocodylus, 56–8
adrena, Nymphaea, 117
aeneus, Aneides, 86
  Tetragonopterus, 143
Aesculus californica, 42
aestivus, Opheodrys, 208
aepyptera, Lampetra, 118, 160, 225–30
aepypterus, Eudontomyzon, 226
Aequidens coeruleopunctatus, 146
  portalegrensis, 24–5
aesculapius, Gadus, 239
aestivalis, Pomolobus, 237
affinis, Pituophis catenifer, 243
Afrixalus, 123
Agama agama, 122
agama, Agama, 122
agassizi, Gopherus, 128
Agkistrodon, 175
  contortrix laticinctus, 243
    mokeson, 61, 212, 243
  mokeson mokeson, 59
  piscivorus, 59–60, 115, 243
Agonostoma nasutum, 146
Agonostomus, 146
  monticola, 146
  nasutus, 146
ahli, Emoia, 201
alalunga, Germo, 191
alata, Ulmus, 208
albacares, Scomber, 3, 6
  Thunnus, 3, 5, 9
albacora, Neothunnus, 3
  Thynnus, 3
Albacores, 3
albagula, Plethodon glutinosus, 85
albicauda, Pinus, 182
albolabris, Trimeresurus, 163–4
Alepidosaurus aesculapius, 239
aleutensis, Lyconectes, 239
Alfaro amazonus, 198
  cultratus, 198
Alligator mississipiensis, 59
allisoni, Thunnus, 4, 6–8
Alpheus ruber, 99
altifrons, Cichlasoma, 146–7
  Heros, 146
altirostris, Elaps, 125
  Micrurus frontalis, 125
Alutera schoepfi, 115
amaura, Lampropeltis doliata, 243
amazonus, Alfaro, 198
Ambloplites pomotis, 117
Ambystoma, 84, 245
  maculatum, 66, 84
  opacum, 129
  tigrinum, 66
    melanostictum, 170
Ameiurus melas, 119
  natalis, 115
    erebennus, 118
  nebulosus nebulosus, 118
americana, Epinnula orientalis, **137–8**
americanus, Bufo, 211
  Bufo terrestris, 87–8, 129
  Esox, 118
  Pseudopleuronectes, 114
Amphibolurus muricatus, 169
Amphisbaena trachura, 124
Anacharis canadensis, 118
analis, Anchoviella, 194
Anchoa, 193–4
  duodecum, 193
  exigua, 193–4
  mitchilli mitchilli, 194
Anchovia macrolepidota, 142
  scitula, 193–4
Anchoviella, 193–4
  analis, 194
  argyrophanus, 194
  brevirostris, 193
  estanquae, 194
  estauquae, 194
  eurystole, 194
  miarcha, 193–4
  parri, 194
  perfasciata, 193–4
  scitula, 193
Ancistrus chagresi, 145
  (Hypostomus) cirrhosus, 145
Aneides, 84–6
  aeneus, 86
  ferreus, 66
  flavipunctatus, 43
Anguilla rostrata, 118
anguillulatus, Terrapene, 34
  Toxaspis, 34
angulatus, Hemidactylus brooki, 121
angulifer, Epicrates, 243
annectens, Pituophis catenifer, 178, 243
annulata, Lampropeltis doliata, 243
annulatus, Corallus, 243
Anolis, 63, 126
  carolinensis, 59
    carolinensis, 63
  pachypus, 126
  pentaprion, 126
  sagrei, 53, 63
    ordinatus, 63
    sagrei, 63
    stejnegeri, 63
Anops kingi, 125
Anopsibaena kingi, 125
antarcticus, Acanthophis, 167
anthicus, Coluber constrictor, 44
antipex, Terrapene, 34–5
Aphanius, 198
Aphredoderus sayanus sayanus, 118
Aporarchus prunicolor, 124
Aporophis cyanopleurus, 124

appendix, Entosphenus, 229
Arctostaphylos glauca, 179
pungens, 179
Arctotherium, 175, 179
arenicolor, Hyla, 180
argentivittatus, Neothunnus, 3, 5–6
argyrophanus, Anchoviella, 194
Engraulis, 194
arioides, Bagrus, 144
Arius multiradiatus, 144
armatum, Pteridium, 224
armatus, Dicrotus, 140
arnoensis, Emoia, 201–7
Asellus, 88
Astroblepus grixalvii, 144
Astyanax, 148
sp., 143
Atherina harringtonensis, 189
Atheris chloroechis, 122
atlanticus, Thunnus, 7
atra, Naja naja, 243
atricaudatus, Brycon, 142
Chalceus, 142
Atriplex, 179
lentiformis, 179
atrocostata, Emoia, 201
atrox, Crotalus, 175, 178, 243
Felis, 179
atrum, Pteridium, 224
attenuatus, Batrachoseps attenuatus, 62
atun, Thyrsites, 139–40
aubryi, Leptopelis, 123
auriculatus, Desmognathus fuscus, 59
auritus, Lepomis, 118
avivoca, Hyla, 63
Awaous stamineus, 222

Bagrus arioides, 144
baileyi, Crotaphytus collaris, 178
Natrix, 92
Thermophis, 92–4
Tropidonotus, 92, 94
Bairdiella chrysura, 240
baliogaster, Helicops, 124
Balistes carolinensis, 185
balteatus, Richardsonius balteatus, 116
barbata, Brotula, 217
barbouri, Eunectes, 243
Barisia monticola, 126
Basicladia, 61
chelonum, 61
crassa, 61
basiliscus, Crotalus basiliscus, 243
Bathylagus, 97
Bathymacrops, 97
Batrachoseps, 62
attenuatus attenuatus, 62
wrighti, 65–6
baudini, Smilisca baudini, 81
bauri, Terrapene carolina, 38
bayanus, Pomadasis, 146
Pomadasys, 146
beldingi, Cnemidophorus hyperythrus, 177
belli, Chrysemys picta, 61
Benthenchelys, 237
bicolor, Loxocemus, 243
Bidenichthys, 219
bimaculatum, Cichlasoma, 235
bimaculatus, Hemichromis, 235
Bipinnula, 136
violacea, 135–6
bislineata, Eurycea, 87
Eurycea bislineata, 86
Bison, 179
Bitis gabonica gabonica, 122
bivittatus, Python molurus, 243
blanchardi, Neoclinus, 12–21
blandingi, Emys, 35, 61
Mabuya, 122
Boa constrictor constrictor, 243
imperator, 243
Boaedon lineatus, 122
virgatus, 122
boettgeri, Emoia, 201–2, 204
Emoia boettgeri, 203
Boiga dendrophila, 243
fusca, 167
pulverulenta, 122
Bolitoglossa cephalica, 42
galeanae, 42
italicus, 42
boreas, Bufo boreas, 172, 174
Boreogadus saida, 238
Bothragonus swani, 239
Bothrops, 175
Brachydanio rerio, 102
brachyphona, Pseudacris, 81, 88
Brasenia schreberi, 117
brasiliensis, Hemiramphus, 189
Macrodon, 143
Macrodon (Erythrinus), 143
brevifolia, Yucca, 49
brevipes, Lycodes, 151
brevirostris, Anchoviella, 193
Hippocampus, 99
Brontes prenadilla, 144
brooksi, Lampropeltis getulus, 243
brosme, Brosmius, 222
Brosmius brosme, 222
Brosmophycis, 219
Brotula, 216–7, 219, 221–4
barbata, 217
marginalis, 217
multibarbata, 215–8, 221, 224
multicirrata, 217
ordwayi, 217
townsendi, 215–8
Brotulina, 219
Brycon atricaudatus, 142
chagrensis, 143
striatulus, 142
bryope, Calliblennius, 17
Neoclinus, 12–7, 19
Zacalles, 12, 17
Bufo, 86–7, 211
americanus, 211
boreas boreas, 172, 174
halophilus, 182
canorus, 182
cognatus, 180–1, 211
d'orbignyi, 125
fowleri, 211
nayaritensis, 181
regularis, 123
terrestris, 59, 211
americanus, 87–8, 129
valliceps, 208–9, 211–2
woodhousei, 181, 211
fowleri, 87–8, 129, 181, 187
woodhousei, 181
bulverda, Terrapene, 35
burtoni, Hyperolius, 123

caeruleus, Elgaria caeruleus, 176
Calanus finmarchicus, 195
Calcarbrotula, 219
calidiarum, Phrynosoma, 187
californiae, Lampropeltis getulus, 243
californica, Aesculus, 42
Juniperus, 179
callarius, Gadus, 238
Calliblennius, 12, 17
bryope, 17
Callinectes sapidus, 240
Cambarus, 88
canadensis, Anacharis, 118
canaliculata, Terrapene, 34–8
Canis dirus, 179
canorus, Bufo, 182
capito, Gobius, 222
caprodes, Percina, 28, 30
Carcharias taurus, 239–40
Caretta caretta caretta, 184
caretta, Caretta caretta, 184
carolina, Terrapene, 33–8
Terrapene carolina, 38–9
carolinensis, Anolis, 59
Anolis carolinensis, 63
Balistes, 185
Desmognathus ochrophaeus, 84
carolinus, Trachinotus, 5
Carphophis, 86
castaneus, Ichthyomyzon, 160–1
Cataetyx, 219
catalinae, Neothunnus, 8–9
Thunnus, 8
catenatus, Sistrurus, 243
Sistrurus catenatus, 128
catenifer, Pituophis, 174, 178–9
Pituophis catenifer, 178, 243
catesbeiana, Rana, 60, 73, 78, 89, 187, 208
catesbyi, Heterodon, 64
Leptognathus, 124
Causus rhombeatus, 122
Centrolophus niger, 237
Centropomus undecimalis, 240
cephalica, Bolitoglossa, 42
cephalus, Mugil, 192, 240–1
Ceuthophilus gracillipes, 60
Chaenopsis, 11
Chaetomorpha chelonum, 61
chagrensis, Brycon, 143
Chalcinopsis, 143
chagresi, Ancistrus, 145
Pimelodella, 144
Chalceus atricaudatus, 142
Chalcinopsis chagrensis, 143
striatulus, 142–3
Chamaeleo bitaeniatus ellioti, 59
leikipiensis, 59
cristatus, 122
jacksoni, 59
oweni, 122
Charina bottae utahensis, 174
chelonum, Basicladia, 61
Chaetomorpha, 61
Chelydra, 61
serpentina, 208
serpentina, 61
Chimaera, 117
monstrosa, 117
chloroechis, Atheris, 122
Chrysemys, 61
picta belli, 61
marginata, 61
chrysotus, Fundulus, 198
chrysura, Bairdiella, 240
Cichlasoma altifrons, 146–7
bimaculatum, 235
cinerascens, Pimelodus, 144
Rhamdia, 144
cirrhosus, Ancistrus (Hypostomus), 145
cirrigera, Eurycea bislineata, 59, 86
Cirripectus, 11
Cistudo, 34
eurypygia, 34
marnochi, 34
clamitans, Rana, 60, 73–5, 88–9, 187
Clemmys, 179
marmorata, 174, 177
clarki, Pseudacris, 81
Clupea harengus, 188, 195, 237
Cnemidophorus, 50, 177
hyperythrus beldingi, 177
sexlineatus, 177
tigris, 174, 177
coeruleopunctata, Acara, 146
coeruleopunctatus, Aequidens, 146
cognatus, Bufo, 180–1, 211
collaris, Crotaphytus, 177
Coluber, 163
constrictor, 44, 208
anthicus, 44
constrictor, 44, 60
flaviventris, 44–5
haasti, 45
mormon, 44
paludicola, 44
priapus, 44–5
stejnegerianus, 44
flagellum, 208
simus, 64
coluber, Gempylus, 139
columbi, Mammuthus, 38
Conger oceanicus, 237
Conocarpus erecta, 58
constrictor, Boa constrictor, 243
Coluber, 44
Coluber constrictor, 44, 60
continentalis, Ungaliophis, 243
contortrix, Heterodon contortrix, 60
cooki, Corallus enydris, 243
copelandi, Hadropterus, 26–30
Corallus annulatus, 243
enydris cooki, 243
coronoides, Denisonia, 167
coryi, Liocephalus carinatus, 50–3
Coryphaena hippurus, 195
Cottogaster, 26
couperi, Drymarchon corais, 243
crassa, Basicladia, 61
Crassostrea virginica, 240
crassus, Epicrates cenchria, 243
crenularis, Tarletonbeania, 190–2
crepitans, Acris, 187, 208
cristatus, Chamaeleo, 122
Crocodylus acutus, 56–8
cromis, Pogonias, 240
crossi, Mehelya, 122
Crotalus, 175–6, 178
adamanteus, 243
atrox, 175, 178, 243
basiliscus basiliscus, 243
cerastes lateorepens, 243
durissus durissus, 243
horridus, 212
horridus, 60, 212, 243

mitchelli, 178
pyrrhus, 243
potterensis, 174–5
ruber ruber, 243
tortugensis, 243
unicolor, 243
viridis, 174–6, 178–9
helleri, 176, 243
lutosus, 176
viridis, 243
Crotaphopeltis duchesnii duchesnii, 122
Crotaphytus, 177–8
collaris, 177
baileyi, 178
crucifer, Hyla, 187
Hyla crucifer, 81, 88, 173
cruentatum, Kinosternon cruentatum, 65
crysoleucas, Notemigonus crysoleucas, 118
cubensis, Squalis, 142
cultratus, Alfaro, 198
cunninghami, Egernia, 169
curtus, Python curtus, 243
cyanopleurus, Aporophis, 124
cyanura, Emoia, 206
cyclopion, Natrix, 127
Natrix cyclopion, 127
Cynoscion nebulosus, 240

daggetti, Felis, 179
Dajaus elongatus, 146
monticola, 146
nasutus, 146
danielsi, Gyrinophilus, 86
Dasia smaragdina, 207
Dasypeltis scaber fasciatus, 122
Decapterus marcarellus, 237
Demansia textilis, 167
Dendroaspis viridis, 243
dendrophila, Boiga, 243
Dendrophis punctulatus, 167
Denisonia coronoides, 167
flagellum, 167
dentatus, Paralichthys, 195
Dermatopsis, 219
deschauenseei, Eunectes, 243
deserticola, Pituophis catenifer, 178
Desmognathus fuscus, 85
auriculatus, 59
welteri, 84
monticola, 85
ochrophaeus carolinensis, 84
ochrophaeus, 84
Diadophis punctatus punctatus, 59
diastictus, Pseudotriton montanus, 86
Dicamptodon, 43
ensatus, 43
Dicrotus, 140
armatus, 140
parvipinnis, 140
Dinematichthys, 216, 219–24
iluocoeteoides, 221–2, 224
Diplodactylus spinigerus, 169
Dipulus, 219
dirus, Canis, 179
Dolichopterygiella, 97
Dolichopteryx, 96–7
longipes, 97
d'orbignyi, Bufo, 125
dorsalis, Rhinophrynus, 65
Drymarchon corais couperi, 243
duchesnii, Crotaphopeltis duchesnii, 122
duodecum, Anchoa, 193
durissus, Crotalus durissus, 243
duryi, Gyrinophilus porphyriticus, 86

Echeneis naucrates, 190
Echinocystis fabacea, 179
edulus, Pinus, 180
Egernia cunninghami, 169
Elaphe, 92, 95
emoryi, 90–1
frenata, 95
guttata guttata, 243
moellendorffii, 123
obsoleta, 208
obsoleta, 243
quadrivittata, 243
spiloides, 243
oxycephala, 95
prasina, 95
Elaps altirostris, 125
Eleotris picta, 147
pictus, 147
Eleutherodactylus, 126
punctariolus, 126
rhodopis, 126
Elgaria, 176–7
caeruleus caeruleus, 176
palmeri, 176
shastensis, 176
multicarinata, 174, 176
webbi, 176
ellioti, Chamaeleo bitaeniatus, 59
elongatus, Dajaus, 146
Emblemaria, 11
Emoia, 201–6
ahli, 201
arnoensis, 201–7
atrocostata, 201
boettgeri, 201–2, 204
boettgeri, 203
orientalis, 202–3, 204, 205–7
cyanura, 206
flavigularis, 201–3, 205
kukenthali, 201
nigra, 201–3, 205
nigrita, 201
nigromarginata, 201
samoensis, 201
sorex, 201
speiseri, 201
whitneyi, 201
emoryi, Elaphe, 90–1
Emys blandingi, 35, 61
Engraulis argyrophanus, 194
macrolepidota, 142
mordax, 193–4
Poeyi, 142
Enneacanthus gloriosus, 118
Ensatina, 43
eschscholtzi, 43, 66
ensatus, Dicamptodon, 43
Entosphenus appendix, 229
lamottenii, 157, 229
Epicrates angulifer, 243
cenchria crassus, 243
maurus, 243
striatus, 243
Epinnula, 135, 138–9
magistralis, 138, 140
orientalis, 135, 137–8, 140
americana, 137–8
orientalis, 138
pacifica, 138

erebennus, Ameiurus natalis, 118
erecta, Conocarpus, 58
Erimyzon oblongus oblongus, 118
erochrous, Hololepis fusiformis, 118
erythrogaster, Natrix, 208
eschscholtzi, Ensatina, 43, 66
Escolar, 135–6
  violaceus, 135–6
Esox americanus, 118
  lucius, 24
  niger, 118
estanquae, Anchoviella, 194
estauquae, Anchoviella, 194
Etheostoma nigrum, 28
Etrumeus sadina, 194
Euceratherium, 175, 177
Eudontomyzon aepypterus, 226
Eudynamis taitensis, 206
Eumeces, 50, 79, 177
  fasciatus, 59
  gilberti, 174, 177
  laticeps, 59
  obsoletus, 186
Eunectes barbouri, 243
  deschauenseei, 243
  murina, 243
Euphausia pacifica, 191
Euproserpa, 97
Eurycea bislineata, 87
    bislineata, 86
    cirrigera, 59, 86
  longicauda guttolineata, 59, 87
    longicauda, 87
eurypygia, Cistudo, 34
  Terrapene, 34
eurystole, Anchoviella, 194
  Stolephorus, 194
Eutyx, 219
exigua, Anchoa, 193–4
eximia, Hyla, 80–?

fabacea, Echinocystis, 179
falcatus, Trachinotus, 5
fasciata, Natrix sipedon, 59–60
  Tropidodipsas, 187
fasciatus, Dasypeltis scaber, 122
  Hemidactylus fasciatus, 122
  Macrodon, 143
Felis atrox, 179
  daggetti, 179
feriarum, Pseudacris nigrita, 81
ferreus, Aneides, 66
Fierasfer, 222
  acus, 222
finmarchicus, Calanus, 195
flagellum, Coluber, 208
  Denisonia, 167
flavescens, Kinosternon, 208
flavigularis, Emoia, 201–3, 205
flavipunctatus, Aneides, 43
flaviventris, Coluber constrictor, 44–5
flavobrunneum, Lepidocybium, 136, 138, 140
floridana, Natrix cyclopion, 127
floridanus, Micropterus salmoides, 116
fontinalis, Salvelinus, 107, 235
formosa, Terrapene, 34
fossor, Ichthyomyzon, 157–8, 160
fowleri, Bufo, 211
  Bufo woodhousei, 87–8, 129, 181, 187
frenata, Elaphe, 95
Fundulus, 103, 192
  chrysotus, 198
  heteroclitus, 24, 102–5, 107, 192
  majalis, 192
  sp., 104
Furcipenis, 198
fusca, Boiga, 167
fuscus, Desmognathus, 85
  Opheomorphus, 124–5

gabonica, Bitis gabonica, 122
Gadus callarius, 238
gagei, Ichthyomyzon, 152–5, 157–8, 160–1
gairdneri, Salmo, 24, 126, 234
galeanae, Bolitoglossa, 42
Gambelia, 177–8
  wislizeni, 174, 177–8
    silas, 178
    wislizeni, 178
Gambusia, 148, 151
garmani, Leptognathus, 124–5
Gastropyxis smaragdina, 122
Gempylus, 139–40
  coluber, 139
  serpens, 139–41
geographica, Graptemys, 61
Geospiza, 206
Germo alalunga, 191
getulus, Lampropeltis, 174, 179
  Lampropeltis getulus, 59
gibbosus, Lepomis, 118
gilli, Mollienisia sphenops, 145
  Synchirus, 239
Gillii, Xiphophorus, 145
glauca, Arctostaphylos, 179
glaucus, Trachinotus, 5
gloriosus, Enneacanthus, 118
glutinosus, Plethodon, 85
  Plethodon glutinosus, 59, 85
Gobius capito, 222
goodei, Phrynosoma, 186–7
  Ptilichthys, 239
  Sebastodes, 191
Gopherus agassizi, 174, 177
  polyphemus, 128
Gorgasia, 237
  punctata, 236–7
gracillipes, Ceuthophilus, 60
graciosus, Sceloporus, 174, 177
Graptemys geographica, 61, 181
greeleyi, Ichthyomyzon, 155
gribinguiensis, Rana oxyrhynchus, 123
Grimaldia, 97
grixalvii, Astroblepus, 144
Gronovii, Tetragonopterus, 143
gryllus, Acris gryllus, 59
guentheri, Holaspis, 122
guerreroensis, Tropidodipsas, 187–8
guildi, Semathunnus, 8
guirali, Mehelya, 122
guttata, Elaphe guttata, 243
guttolineata, Eurycea longicauda, 59, 87
guttulata, Hypsopsetta, 114
Gymnodactylus miliusi, 169
  platurus, 169
Gyrinophilus danielsi, 86
  porphyriticus, 86
    duryi, 86

haasti, Coluber constrictor, 45
Hadropterus, 26–7
  copelandi, 26–30
  maculatus, 26, 29–30
  shumardi, 26
  uranidea, 26

haemachatus, Hemachatus, 243
Halaphya, 97
halophilus, Bufo boreas, 182
hammondi, Scaphiopus, 65
hannah, Ophiophagus, 243
Hannemania, 180
harengus, Clupea, 188, 195, 237
harringtonensis, Atherina, 189
Helicops baliogaster, 124
schistosus, 243
helleri, Crotalus viridis, 176, 243
Hemachatus haemachatus 243
Hemichromis bimaculatus, 235
Hemidactylium scutatum, 129, 180
Hemidactylus brooki angulatus, 121
fasciatus fasciatus, 122
Hemiramphus brasiliensis, 189
Heros altifrons, 146
Sieboldii, 147
heteroclitus, Fundulus, 24, 102–5, 107, 192
Heterodon catesbyi, 64
contortrix contortrix, 60
nasicus, 64, 164
platyrhinos, 64, 162, 164
simus, 64
himalayana, Natrix, 95
Hippocampus brevirostris, 99
hudsonius, 98
Hippomane mancinella, 31
hippurus, Coryphaena, 195
Holaspis guentheri, 122
Holbrookia, 50
Hololepis fusiformis erochrous, 118
Hoplias microlepis, 143
Hoplobrotula, 219
horridus, Crotalus, 212
Crotalus horridus, 60, 212, 243
hudsonius, Hippocampus, 98
humile, Pristipoma, 146
Hyalorhynchus, 96
natalensis, 96
Hydromantes, 39–40, 42–3
platycephala, 39–40, 42–3
shastae, 39–43
Hyla, 80–3
arenicolor, 180
avivoca, 63
crucifer, 187
crucifer, 81, 88, 173
eximia, 80–2
lafrentzi, 81
miotympanum, 81
phaeocrypta, 63–4
picta, 81
regilla, 80–2, 186
rickardsi, 81
septentrionalis, 127–8
smithi, 81
squirella, 81
staufferi, 81
underwoodi, 81
versicolor, 63–4, 81, 89
versicolor, 89
wrightorum, 80–2
Hylodes, 82
ocularis, 83
Hyperolius, 123
burtoni, 123
Hypostomus plecostomus, 144
Hypsopsetta, 115
guttulata, 114

Ichthyomyzon castaneus, 160–1
fossor, 157–8, 160
gagei, 152–5, 157–8, 160–1
greeleyi, 155
unicuspis, 157
iluocoeteoides, Dinematichthys, 221–2, 224
impensa, Terrapene, 35
imperator, Boa constrictor, 243
inoxia, Terrapene, 34
intermedia, Siren, 62, 119–21
Siren intermedia, 59, 121
Ipomea pes-capri, 58
itaiara, Promicrops, 190
italicus, Bolitoglossa, 42
itosibi, Neothunnus, 4, 8

jacksoni, Chamaeleo, 59
jordani, Pantosteus, 116
juliflora, Prosopis, 208
Juniperus californica, 179
utahensis, 180

Kaloula, 64
Katsuwonus pelamis, 7
kellogi, Quercus, 42
kingi, Anops, 125
Anopsibaena, 125
Kinosternon cruentatum cruentatum, 65
flavescens, 208
kirtlandi, Thelatornis kirtlandi, 122
kukenthali, Emoia, 201

lafrentzi, Hyla, 81
lamottei, Lampetra, 157, 161, 229
lamottenii, Entosphenus, 157, 229
(Okkelbergia) Lampetra, 226
Lampetra, 227
aepyptera, 118, 160, 225–30
lamottei, 157, 161, 229
(Okkelbergia) lamottenii, 226
planeri, 154, 156, 159
Lampropeltis, 179
doliata amaura, 243
annulata, 243
getulus, 174, 179
brooksi, 243
californiae, 243
getulus, 59
zonata multicincta, 243
laterorepens, Crotalus cerastes, 243
laticeps, Trichomycterus, 144
laticinctus, Agkistrodon contortrix, 243
lecontei, Rhinocheilus lecontei, 243
leikipiensis, Chamaeleo bitaeniatus, 59
Leiostomus xanthurus, 240
lentiformis, Atriplex, 179
Lepidocybium, 138–9
flavobrunneum, 136, 138, 140
lepidopoides, Thyrsitops, 139–40
Lepisosteus platyrhynchus, 232
Lepomis auritus, 118
gibbosus, 118
macrochirus, 208
macrochirus, 118
Leptognathus, 124
catesbyi, 124
garmani, 124–5
Leptopelis aubryi, 123
millsoni, 123
Leuroglossus, 97
Liasis olivaceous, 167

Lichanura roseofusca roseofusca, 243
Limnaoedus, 81, **83**
ocularis, 81, 83
lima, Loricaria, 145
limi, Umbra, 232–3
lineata, Salvadora, 208
lineatus, Boaedon, 122
Pseudochalceus, 143
Liocephalus carinatus coryi, 50, 53
Liopeltis, 92
Liophis miliaris semiaureus, 125
poecilogyrus, 162
Ilanensis, Terrapene, **35**–8
longicauda, Eurycea longicauda, 87
longinsulae, Terrapene, 34
longipes, Dolichopteryx, 97
Loricaria lima, 145
uracantha, 145
louisianae, Syngnathus, 99
louisianensis, Triturus viridescens, 62–3, 84
Loxocemus bicolor, 243
Lucifuga, 219
lucius, Esox, 24
lutosus, Crotalus viridis, 176
Lycengraulis poeyi, 142
Lycodes brevipes, 151
Lyconectes aleutensis, 239

Mabuya blandingi, 122
maculilabris maculilabris, 122
Macrobdella, 66
macrochirus, Lepomis, 208
Lepomis macrochirus, 118
Macrodon, 143
brasiliensis, 143
(Erythrinus) brasiliensis, 143
fasciatus, 143
microlepis, 143
macrolepidota, Anchovia, 142
Engraulis, 142
macrophyllum, Acer, 42
Macropinna, 96–7
microstoma, 96
macropterus, Thunnus, 8–9
Thynnus, 8
macropus, Ophthalmopelton, 96
macrourus, Sternopygus, 144
macrurus, Sternopygus, 144
maculatum, Ambystoma, 66, 84
maculatus, Hadropterus, 26, 29–30
maculilabris, Mabuya maculilabris, 122
magister, Sceloporus, 177
magistralis, Epinnula, 138, 140
Magnadigitata subpalmata, 126
majalis, Fundulus, 192
major, Terrapene, 34–5, 37–8
Terrapene carolina, 38
malachiticus, Sceloporus malachiticus, 126
Mammut, 175, 177
Mammuthus columbi, 38
mancinella, Hippomane, 31
mangle, Rhizophora, 57
maniculatus, Peromyscus, 211
mantidactyla, Pseudis, 125
marcarellus, Decapterus, 237
marcianus, Thamnophis, 208
marginalis, Brotula, 217
marginata, Chrysemys picta, 61
marinus, Petromyzon, 154, 157–9
maritima, Suriana, 57
marleyi, Thyrsitoides, 139–40
marmorata, Clemmys, 174, 177
marnochi, Cistudo, 34
Terrapene, 35
mascareniensis, Rana mascareniensis, 123
Masticophis flagellum piceus, 243
testaceus, 243
Mastodon, 179
maurus, Epicrates cenchria, 243
Megalonyx, 175
Mehelya crossi, 122
guirali, 122
poensis, 122
melanoleuca, Naja, 243
melanoleucus, Pituophis melanoleucus, 59, 183–4, 243
melanopleurus, Phalotris, 124
Melanoseps occidentalis, 122
melanostictum, Ambystoma tigrinum, 170
melas, Ameiurus, 119
Membras vagrans, 189
miarcha, Anchoviella, 193–4
Microbrotula, 217, **218**, 219, 221–4
nigra, 217–9, **220**, 222, 224
rubra, 217, **218**–9, 220
microlepis, Hoplias, 143
Macrodon, 143
Micropterus, 116
salmoides, 208, 236
floridanus, 116
salmoides, 118
Microsaura pumila pumila, 59
Microspora, 61
Microstoma, 97
microstoma, Macropinna, 96
Micrurus frontalis altirostris, 125
miliarius, Sistrurus miliarius, 59
millsoni, Leptopelis, 123
miluisi, Gymnodactylus, 169
Mimasea, 139–40
taeniosoma, 139, 141
miotympanum, Hyla, 81
mississipiensis, Alligator, 59
mitchelli, Crotalus, 178
mitchilli, Anchoa mitchilli, 194
modestus, Pimelodus, 144
moellendorffi, Elaphe, 123
mokeson, Agkistrodon contortrix, 61, 212, 243
Agkistrodon mokeson, 59
Mola mola, 192
mola, Mola, 192
Mollienisia sphenops, 145
gilli, 145
mollis, Schilbeodes, 118
molurus, Python molurus, 243
Monacoa, 97
monophyla, Pinus, 179
Monothrix, 219
monstrosa, Chimaera, 117
montezumae, Xiphophorus, 148–50
monticola, Agonostomus, 146
Barisia, 126
Dajaus, 146
Desmognathus, 85
mordax, Engraulis, 193–4
mormon, Coluber constrictor, 44
Mugil, 192, 240
cephalus, 192, 240–1
multibarbata, Brotula, 215–8, 221, 224
multicarinata, Elgaria, 174, 176
multicincta, Lampropeltis zonata, 243
multicirrata, Brotula, 217
multiradiatus, Arius, 144
muricatus, Amphibolurus, 169

murina, Eunectes, 243
murrayana, Pinus, 182
Myiarchus, 206
Mylodon, 177, 179
Myriophyllum, 63, 120

Naja melanoleuca, 243
  naja, 243
    atra, 243
  nigricollis, 243
    nigricollis, 122
  nivea, 243
naja, Naja, 243
Nansenia, 97
nasicus, Heterodon, 64, 164
nasutum, Agonostoma, 146
nasutus, Agonostomus, 146
  Dajaus, 146
  Nesiarchus, 135–7, 139–40
natalensis, Hyalorhynchus, 96
  Rhynchohyalus, 96
natalis, Ameiurus, 115
Natrix, 94–5
  baileyi, 92
  cyclopion, 127
  - cyclopion, 127
    floridana, 127
  erythrogaster, 208
  himalayana, 95
  sipedon fasciata, 59–60
  taxispilota, 60
naucrates, Echeneis, 190
nayaritensis, Bufo, 181
Nealotus, 139–40
  tripes, 139–40
nebulosus, Ameiurus nebulosus, 118
  Cynoscion, 240
Necturus punctatus, 59
Neoclinus, 11–2, 15–7
  blanchardi, 12–21
  bryope, 12–7, 19
  satiricus, 12, 14, 19–21
  sp., 18
  stephensae, 14, 15–7, 19
  uninotatus, 14–7, 18–20
Neoepinnula orientalis, 138
Neothunnus, 4
  albacora, 3
  argentivittatus, 3, 5–6
  catalinae, 8
  itosibi, 4, 8
Nesiarchus, 135–6, 140
  nasutus, 135–7, 139–40
nettingi, Siren intermedia, 63, 121
niger, Centrolophus, 237
  Esox, 118
  Thyrsites, 136, 140
nigra, Microbrotula, 217–9, **220,** 222, 224
nigra, Emoia, 201–3, 205
nigricollis, Naja, 243
  Naja nigricollis, 122
nigrita, Emoia, 201
  Pseudacris nigrita, 81
nigromaculatus, Pomoxis, 118
nigromarginata, Emoia, 201
nigrum, Etheostoma, 28
nivea, Naja, 243
Notechis scutatus, 167
Notemigonus crysoleucas crysoleucas, 118
Nothrotherium, 175, 177
Notropis volucellus, 28
Nymphaea advena, 117

obesus, Thunnus, 7
oblongus, Erimyzon oblongus, 118
obsoleta, Elaphe, 208
  Elaphe obsoleta, 243
occidentalis, Melanoseps, 122
  Sceloporus, 53, 174, 177
oceanicus, Conger, 237
ocellata, Sciaenops, 240
ocellatus, Zenopsis, 195
ochrophaeus, Desmognathus ochrophaeus, 84
ocularis, Hylodes, 83
  Limnaoedus, 81, **83**
  Pseudacris, 80–2
odoratus, Sternotherus, 60–1
Oedipus subpalmatus, 126
Ogilbia, 219
olivaceous, Liasis, 167
Oncorhynchus, 150
  tshawytscha, 151
opacum, Ambystoma, 129
Opheodrys aestivus, 208
Opheomorphus fuscus, 124–5
Ophioblennius, 11
Ophiophagus hannah, 243
Ophthalmopelton, 96–7
  macropus, 96
Opisthoproctus, 97
Orcynus subulatus, 6, 8
ordinatus, Anolis sagrei, 63
ordwayi, Brotula, 217
oregonense, Ptychocheilus, 116
oregonium, Prosopium, 116
orientalis, Emoia boettgeri, 202–3, **204,** 205–7
orientalis, Acanthodactylus tristami, 66
  Epinnula, 135, 137–8, 140
  Epinnula orientalis, 138
  Neoepinnula, 138
ornata, Pseudacris, 81
  Terrapene, 34–5, 37
Othos, 219
oweni, Chamaeleo, 122
oxycephala, Elaphe, 95
Oxyuranus scutellatus, 167

pachypus, Anolis, 126
pacifica, Epinnula orientalis, **138**
pacifica, Euphausia, 191
palmeri, Elgaria caeruleus, 176
Paludicola ranina, 124
paludicola, Coluber constrictor, **44**
palustris, Rana, 60
panamensis, Plecostomus plecostomus, 144–5
Pantosteus, 116
  jordani, 116
paradoxus, Prometheus, 135
Paralichthys, 5
  dentatus, 195
Paramylodon, 38
Paraneetroplus sieboldi, 147
parietalis, Thamnophis sirtalis, 173
parri, Anchoviella, 194
parvipinnis, Dicrotus, 140
paucispinus, Sebastodes, 191
Pelamis platurus, 124
pelamis, Katsuwonus, 7
Penaeus setiferus, 240
pentaprion, Anolis, 126
Percina, 30
  caprodes, 28, 30
perfasciata, Anchoviella, 193–4
Periophthalmus, 198
Peromyscus maniculatus, 211

pes-capri, Ipomea, 58
Petromyzon marinus, 154, 157–9
Petrotyx, 219
phaeocrypta, Hyla, 63–4
Phalotris melanopleurus, 124
Phrynosoma, 50
  platyrhinos, 186
    calidiarum, 187
    goodei, 186–7
pica, Turbo, 32
piceus, Masticophis flagellum, 243
picta, Eleotris, 147
  Hyla, 81
pictus, Eleotris, 147
Pimelodella chagresi, 144
Pimelodus cinerascens, 144
  modestus, 144
Pinus albicauda, 182
  edulus, 180
  monophyla, 179
  murrayana, 182
  sabiniana, 42
pipiens, Rana, 60, 73, 76–7, 173, 187, 208
piscivorus, Agkistrodon, 59–60, 115, 243
Pisidium abditum, 60
Pituophis catenifer, 174, 178–9
    affinis, 243
    annectens, 178, 243
    catenifer, 178, 243
    deserticola, 178
    sayi, 174
  melanoleucus melanoleucus, 59, 183–4, 243
planeri, Lampetra, 154, 156, 159
platurus, Gymnodactylus, 169
  Pelamis, 124
platycephala, Hydromantes, 39–40, 42–3
Platygonus, 175
platyrhinos, Heterodon, 64, 162, 164
  Phrynosoma, 186
platyrhynchus, Lepisosteus, 232
Plecostomus plecostomus panamensis, 144–5
plecostomus, Hypostomus, 144
Plethodon, 85
  glutinosus, 85
    albagula, 85
    glutinosus, 59, 85
  richmondi, 85
Pleuronichthys, 115
  ritteri, 115
  verticalis, 115
poecilogyrus, Liophis, 162
poensis, Mehelya, 122
Poeyi, Engraulis, 142
poeyi, Lycengraulis, 142
Pogonias cromis, 240
Pollachius virens, 237
polygrammicus, Typhlops, 167
polyphemus, Gopherus, 128
Pomadasis bayanus, 146
Pomadasys, 146
  bayanus, 146
Pomatomus, 192
  saltatrix, 192
Pomolobus aestivalis, 237
  pseudoharengus, 237
pomotis, Acantharchus, 117–8
  Ambloplites, 117
Pomoxis nigromaculatus, 118
Populus acuminata, 180
porphyriacus, Pseudechis, 167
porphyriticus, Gyrinophilus, 86
portalegrensis, Aequidens, 24–5
potterensis, Crotalus, 174–5
prasina, Elaphe, 95
prenadilla, Brontes, 144
pretiosa, Rana, 173
pretiosus, Ruvettus, 138, 140
priapus, Coluber constrictor, 44–5
Pristipoma humile, 146
Promethichthys, 139–40
  prometheus, 139–40
Prometheus paradoxus, 135
prometheus, Promethichthys, 139–40
  Thyrsites, 140
Promicrops itaiara, 190
Prosopis juliflora, 208
Prosopium oregonium, 116
prunicolor, Aporarchus, 124
Psammophis sibilans sibilans, 122
Pseudacris, 80–3, 173
  brachyphona, 81, 88
  clarki, 81
  nigrita feriarum, 81
    nigrita, 81
    triseriata, 81, 172, 174
  ocularis, 80–2
  ornata, 81
Pseudechis porphyriacus, 167
Pseudemys scripta, 208
    scripta, 59
Pseudis mantidactyla, 125
Pseudobythites, 219
Pseudochalceus lineatus, 143
pseudoharengus, Pomolobus, 237
Pseudopleuronectes americanus, 114
Pseudotriton montanus diastictus, 86
Pseudotsuga taxifolia, 42
Pseudoxiphophorus, 148
Pteridium armatum, 224
  atrum, 224
Pterognathus, 12
  satiricus, 21
Ptilichthys goodei, 239
Ptychocheilus oregonense, 116
pulverulenta, Boiga, 122
pumila, Microsaura pumila, 59
punctariolus, Eleutherodactylus, 126
punctata, Gorgasia, 236–7
punctatus, Diadophis punctatus, 59
  Necturus, 59
punctulatus, Dendrophis, 167
pungens, Arctostaphylos, 179
putnami, Terrapene, 34
Pygidium, 144
  taenium, 144
pygmaea, Umbra, 118
pygmaeus, Xiphophorus, 148–9
pyrrhus, Crotalus mitchelli, 243
Python curtus curtus, 243
  molurus bivittatus, 243
    molurus, 243
  regius, 122
  reticulatus, 243
  sebae, 243
  spilotes variegata, 167

quadrivittata, Elaphe obsoleta, 243
Quercus kellogi, 42

Rana, 60, 245
  boylei sierrae, 183
  catesbeiana, 60, 73, 78, 89, 187, 208
  clamitans, 60, 73–5, 88–9, 187
  mascareniensis mascareniensis, 123

oxyrhynchus gribinguiensis, 123
palustris, 60
pipiens, 60, 73, 76–7, 173, 187, 208
pretiosa, 173
subsigillata, 123
sylvatica, 60, 66
sylvatica, 89
ranina, Paludicola, 124
raphidoma, Strongylura, 189
regilla, Hyla, 80–2, 186
regius, Python, 122
regularis, Bufo, 123
rerio, Brachydanio, 102
reticulatus, Python, 243
Rexea, 139
solandri, 139–40
rexsalmonorum, Trachipterus, 239
Rhamdia cinerascens, 144
wagneri, 144
Rhinocheilus lecontei lecontei, 243
Rhinophrynus, 65
dorsalis, 65
Rhizoclonium, 61
Rhizophora mangle, 57
rhodopis, Eleutherodactylus, 126
rhombeatus, Causus, 122
Rhombosolea, 114
Rhynchohyalus, 96–7
natalensis, 96
Ribes, 42
Richardsonius balteatus balteatus, 116
richmondi, Plethodon, 85
rickardsi, Hyla, 81
ritteri, Pleuronichthys, 115
robustus, Sceloporus, 177
roseofusca, Lichanura roseofusca, 243
rostrata, Anguilla, 118
ruber, Alpheus, 99
Crotalus ruber, 243
rubra, Microbrotula, 217, 218–9, 220
Ruvettus, 138–9
pretiosus, 138, 140

sabiniana, Pinus, 42
Saccodon wagneri, 142
Wagneri, 142
sadina, Etrumeus, 194
sagrei, Anolis, 53, 63
Anolis sagrei, 63
saida, Boreogadus, 238
salar, Salmo, 192
saliens, Thunnus, 3, 191
Salmo gairdneri, 24, 126, 234
salar, 192
trutta, 235
salmoides, Micropterus, 236
Micropterus salmoides, 118
saltatrix, Pomatomus, 192
Salvadora lineata, 208
Salvelinus fontinalis, 107, 235
samoensis, Emoia, 201
sapidus, Callinectes, 240
Sarda sarda, 195
sarda, Sarda, 195
Sargassum, 116
satiricus, Neoclinus, 12, 14, 19–21
Pterognathus, 21
sauritus, Thamnophis, 208
Thamnophis sauritus, 59
sayanus, Aphredoderus sayanus, 118
sayi, Pituophis catenifer, 174
Scaevola, 206
Scaphiopus, 65
hammondi, 186
Sceloporus, 177
graciosus, 174, 177
magister, 177
malachiticus malachiticus, 126
occidentalis, 53, 174, 177
robustus, 177
undulatus undulatus, 59
Schilbeodes mollis, 118
schistosus, Helicops, 243
schoepfi, Alutera, 115
schreberi, Brasenia, 117
Sciaenops ocellata, 240
scincoides, Tiliqua, 169
scitula, Anchovia, 193–4
Anchoviella, 193
Scomber albacares, 3, 6
sloanei, 3
thynnus, 1
scripta, Pseudemys, 208
Pseudemys scripta, 59
scutatum, Hemidactylium, 129, 180
scutatus, Notechis, 167
scutellatus, Oxyuranus, 167
sebae, Python, 243
Sebastodes goodei, 191
paucispinus, 191
secundodorsalis, Thunnus, 1, 7
secundo-dorsalis, Thynnus, 1
Semathunnus guildi, 8
semiaureus, Liophis miliaris, 125
septentrionalis, Hyla, 127–8
serpens, Gempylus, 139–41
serpentina, Chelydra, 208
Chelydra serpentina, 61
setiferus, Penaeus, 240
sexlineatus, Cnemidophorus, 177
shastae, Hydromantes, 39–43
shastensis, Elgaria caeruleus, 176
shumardi, Hadropterus, 26
sibilans, Psammophis sibilans, 122
sieboldi, Paraneetroplus, 147
Sieboldii, Heros, 147
sierrae, Rana boylei, 183
silas, Gambelia wislizeni, 178
simum, Tremarctotherium, 38
simus, Coluber, 64
Heterodon, 64
singletoni, Terrapene, 34
Sirembo, 219
Siren, 121
intermedia, 62, 119–21
intermedia, 59, 121
nettingi, 63, 121
Sistrurus, 175
catenatus, 243
catenatus, 128
miliarius miliarius, 59
sloanei, Scomber, 3
smaragdina, Dasia, 207
Gastropyxis, 122
Smilisca, 82
baudini baudini, 81
Smilodon, 177
smithi, Hyla, 81
solandri, Rexea, 139–40
sorex, Emoia, 201
Sparganium, 117
speiseri, Emoia, 201
Spelerpes, 39
sphenops, Mollienisia, 145

spiloides, Elaphe obsoleta, 243
spinigerus, Diplodactylus, 169
spiralis, Vallisneria, 118
Squalus, 142
  cubensis, 142
  sucklii, 142
squirella, Hyla, 81
stamineus, Awaous, 222
Stathmonotus, 11
staufferi, Hyla, 81
stejnegeri, Anolis sagrei, 63
  Trimeresurus, 163–4
stejnegerianus, Coluber constrictor, 44
stephensae, Neoclinus, 14, 15–7, 19
Sternopygus macrourus, 144
  macrurus, 144
Sternotherus odoratus, 60–1
Stolephorus eurystole, 194
striatulus, Brycon, 142
  Chalcinopsis, 142–3
striatus, Epicrates, 243
Strongylura raphidoma, 189
Sturnella, 206
Stygicola, 219
subpalmata, Magnadigitata, 126
subpalmatus, Oedipus, 126
subsigillata, Rana, 123
subulatus, Orcynus, 6, 8
  Thunnus, 6
sucklii, Squalus, 142
Suriana maritima, 57
swani, Bothragonus, 239
sylvatica, Rana, 60, 66
  Rana sylvatica, 89
Synchirus gilli, 239
Syngnathus louisianae, 99

taenia, Trichomycterus, 144
taeniosoma, Mimasea, 139, 141
taenium, Pygidium, 144
taitensis, Eudynamis, 206
Tarletonbeania crenularis, 190–2
taurus, Carcharias, 239–40
taxifolia, Pseudotsuga, 42
taxispilota, Natrix, 60
Teius teyou, 125
tenuis, Urophycis, 195
Terrapene, 33–5
  anguillulatus, 34
  antipex, 34–5
  bulverda, 35
  canaliculata, 34–8
  carolina, 33–8
    bauri, 38
    carolina, 38–9
    major, 38
    triunguis, 38
  eurypygia, 34
  formosa, 34
  impensa, 35
  inoxia, 34
  llanensis, 35–8
  longinsulae, 34
  major, 34–5, 37–8
  marnochi, 35
  ornata, 34–5, 37
  putnami, 34
  singletoni, 34
  whitneyi, 35
terrestris, Bufo, 59, 211
testaceus, Masticophis flagellum, 243
Tetragonopterus aeneus, 143
  Gronovii, 143
Tetraodon, 33
Tetrodon, 33
textilis, Demansia, 167
teyou, Teius, 125
Thamnophis, 179
  elegans vagrans, 174
  marcianus, 208
  sauritus, 208
    sauritus, 59
  sirtalis parietalis, 173
Thelatornis kirtlandi kirtlandi, 122
Thermophis, 92, 95
  baileyi, 92–4
Thunnus, 9
  albacares, 3, 5, 9
  allisoni, 4, 6–8
  atlanticus, 7
  catalinae, 8–9
  macropterus, 8–9
  obesus, 7
  saliens, 3, 191
  secundodorsalis, 1, 7
  subulatus, 6
  thynnus, 1
Thynni, 3
Thynnus albacora, 3
  macropterus, 8
  secundo-dorsalis, 1
thynnus, Scomber, 1
  Thunnus, 1
Thyrsites, 139
  atun, 139–40
  niger, 136, 140
  prometheus, 140
Thyrsitoides, 139
  marleyi, 139–40
Thyrsitops, 136, 139
  lepidopoides, 139–40
  violaceus, 135
tigrinum, Ambystoma, 66
tigris, Cnemidophorus, 174, 177
Tiliqua scincoides, 169
tortugensis, Crotalus, 243
townsendi, Brotula, 215–8
Toxaspis, 34
  anguillulatus, 34
Trachinotus, 4
  carolinus, 5
  falcatus, 5
  glaucus, 5
Trachipterus, 236
  rexsalmonorum, 239
  trachyurus, 236
trachura, Amphisbaena, 124
trachyurus, Trachipterus, 236
Tremarctotherium simum, 38
Trichogaster, 103
  trichopterus, 100, 103–4, 106
Trichomycterus, 144
  laticeps, 144
  taenia, 144
trichopterus, Trichogaster, 100, 103–4, 106
Trimeresurus albolabris, 163–4
  stejnegeri, 163–4
tripes, Nealotus, 139–40
triseriata, Pseudacris nigrita, 81, 172, 174
tristami, Acanthodactylus, 66–7
Triturus, 60
  sierrae, 43

viridescens louisianensis, 62–3, 84
viridescens, 60, 84
triunguis, Terrapene carolina, 38
tropicalis, Xenopus, 123
Tropidodipsas guerreroensis, 187–8
fasciata, 187
Tropidonotus baileyi, 92, 94
truncatus, Tursiops, 185
trutta, Salmo, 235
Turbo pica, 32
Tursiops truncatus, 185
Typha, 117
Typhliasina, 219
Typhlops polygrammicus, 167
Tyrannus, 206

Ulmus alata, 208
Umbra limi, 232–3
pygmaea, 118
undecimalis, Centropomus, 240
underwoodi, Hyla, 81
undulatus, Sceloporus undulatus, 59
Ungaliophis continentalis, 243
unicolor, Crotalus, 243
unicuspis, Ichthyomyzon, 157
uninotatus, Neoclinus, 14–7, 18–20
uracantha, Loricaria, 145
uranidea, Hadropterus, 26
Urophycis tenuis, 195
utahensis, Charina bottae, 174
Juniperus, 180

vagrans, Membras, 189
Thamnophis elegans, 174
valliceps, Bufo, 208–9, 211–2
Vallisneria, 149
spiralis, 118
variatus, Xiphophorus, 148–50
Xiphophorus (Platypoecilus), 148
variegata, Python spilotes, 167
versicolor, Hyla, 63–4, 81, 89
Hyla versicolor, 89
verticalis, Pleuronichthys, 115
vigilis, Xantusia, 45, 47, 49
violacea, Bipinnula, 135–6
violaceus, Thyrsitops, 135
Escolar, 135–6
virens, Pollachius, 237
virgatus, Boaedon, 122
virginica, Crassostrea, 240
viridescens, Triturus viridescens, 60, 84
viridis, Acrantus, 125
Crotalus, 174–6, 178–9
Crotalus viridis, 243
Dendroaspis, 243
volucellus, Notropis, 28
vulgaris, Acanthias, 142

Wagneri, Saccodon, 142
wagneri, Rhamdia, 144
Saccodon, 142
webbi, Elgaria multicarinata, 176
welteri, Desmognathus fuscus, 84
whitneyi, Emoia, 201
Terrapene, 35
Winteria, 96–7
wislizeni, Gambelia, 174, 177–8
Gambelia wislizeni, 178
woodhousei, Bufo, 181, 211
Bufo woodhousei, 181, 211
wrighti, Batrachoseps, 65–6
wrightorum, Hyla, 80–2

xanthurus, Leiostomus, 240
Xantusia, 46–8
vigilis, 45, 47, 49
Xenophthalmichthys, 97
Xenopus tropicalis, 123
Xiphophorus, 148–9
Gillii, 145
montezumae, 148–50
pygmaeus, 148–9
variatus, 148–50
(Platypoecilus) variatus, 148

Yucca brevifolia, 49

Zacalles, 12
bryope, 12, 17
Zenopsis ocellatus, 195

COPEIA IS THE JOURNAL OF THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

Officers

Honorary Presidents—JOHN TREADWELL NICHOLS (Ichthyology), American Museum of Natural History, New York 24, New York; HELEN T. GAIGE (Herpetology), 1211 Ferdon Road, Ann Arbor, Michigan.

President—CHARLES M. BOGERT, American Museum of Natural History, New York 24, New York.

Vice-Presidents—(Conservation) JOHN TEE-VAN, New York Zoological Society, New York, New York; (Finance) GEORGE P. MEADE, Colonial Sugars Company, Gramercy, Louisiana; (Membership) GEORGE A. MOORE, Department of Zoology, A. and M. College of Oklahoma, Stillwater, Oklahoma.

Treasurer—COLEMAN J. GOIN, Department of Biology, University of Florida, Gainesville, Florida.

Secretary—ARNOLD B. GROBMAN, Department of Biology, University of Florida, Gainesville, Florida.

Publications Secretary—N. BAYARD GREEN, Biology Dept., Marshall College, Huntington 1, West Virginia.

Editors—Editor-in-Chief, GERALD P. COOPER, Institute for Fisheries Research, University Museums Annex, Ann Arbor, Michigan; Ichthyological Editor, ROBERT R. MILLER, Museum of Zoology, University of Michigan, Ann Arbor, Michigan; Herpetological Editor, NORMAN HARTWEG, Museum of Zoology, University of Michigan, Ann Arbor, Michigan.

Editorial Board—ROLF L. BOLIN, HOWARD K. GLOYD, EARL S. HERALD, L. M. KLAUBER, ERNEST A. LACHNER.

Officers of Western Division

President—GRACE L. ORTON, Scripps Institution of Oceanography, La Jolla, California.

Vice-President—MARTIN R. BRITTAN, Department of Zoology, San Diego State College, San Diego, California.

Secretary-Treasurer—ANITA E. DAUGHERTY, California State Fisheries Laboratory, Terminal Island Station, San Pedro, California.

Honorary Foreign Members

L. F. DE BEAUFORT; L. D. BRONGERSMA; FERNANDO DE BUEN; PAUL CHABANAUD; GEORG DUNCKER; J. GUIBÉ; S. L. HORA; C. C. LIU; NICÉFORO MARIA; ROBERT MERTENS; H. W. PARKER; H. RENDAHL; GIUSEPPE SCORTECCI; J. L. B. SMITH; MALCOLM A. SMITH; A. VEDEL TANING; ETHELWYNN TREWAVAS; DAVID M. S. WATSON; G. F. DE WITTE.

Affiliations

The American Society of Ichthyologists and Herpetologists is a member of the American Institute of Biological Sciences and of the Division of Biology and Agriculture, National Research Council. An annual contribution is made to the publication of the Zoological Record.

Back numbers of COPEIA, as available, may be procured from Prof. N. B. Green, Biology Dept., Marshall College, Huntington, West Virginia. Prices will be furnished on application.

Subscription $6.00 per annum, $1.50 a copy.

Dues to the Society, $5.00 for members from the U.S.A., $4.50 for Canadian and foreign members, including subscription to COPEIA.

Life membership, $100.00, payable in one sum or four annual payments.

Dues and subscriptions are payable to the Society, through the Secretary.

Members should notify the Secretary immediately of any changes in address.

Manuscripts, news items, and all correspondence regarding the Journal should be addressed to one of the Editors.

Manuscripts should be submitted on good paper, as original typewritten copy, double-spaced, carefully corrected. Galley proof will be furnished authors.

Original contributions, not to be published elsewhere, are alone acceptable.

Reprints are furnished at approximate cost.

Figures, author's corrections, expensive tabular matter and unusually long articles may be charged in whole or in part to the author at the discretion of the Editors.

ΙΧΘΤΣ
ΒΑΤΡΑΧΟΣ
ΕΡΠΕΤΟΝ

C37